ARMY ORDNANCE

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For Victory through Armament Research, Production, and Supply

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THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of over 15,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-three years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is geared for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application facing p. 124.) There are twenty-two local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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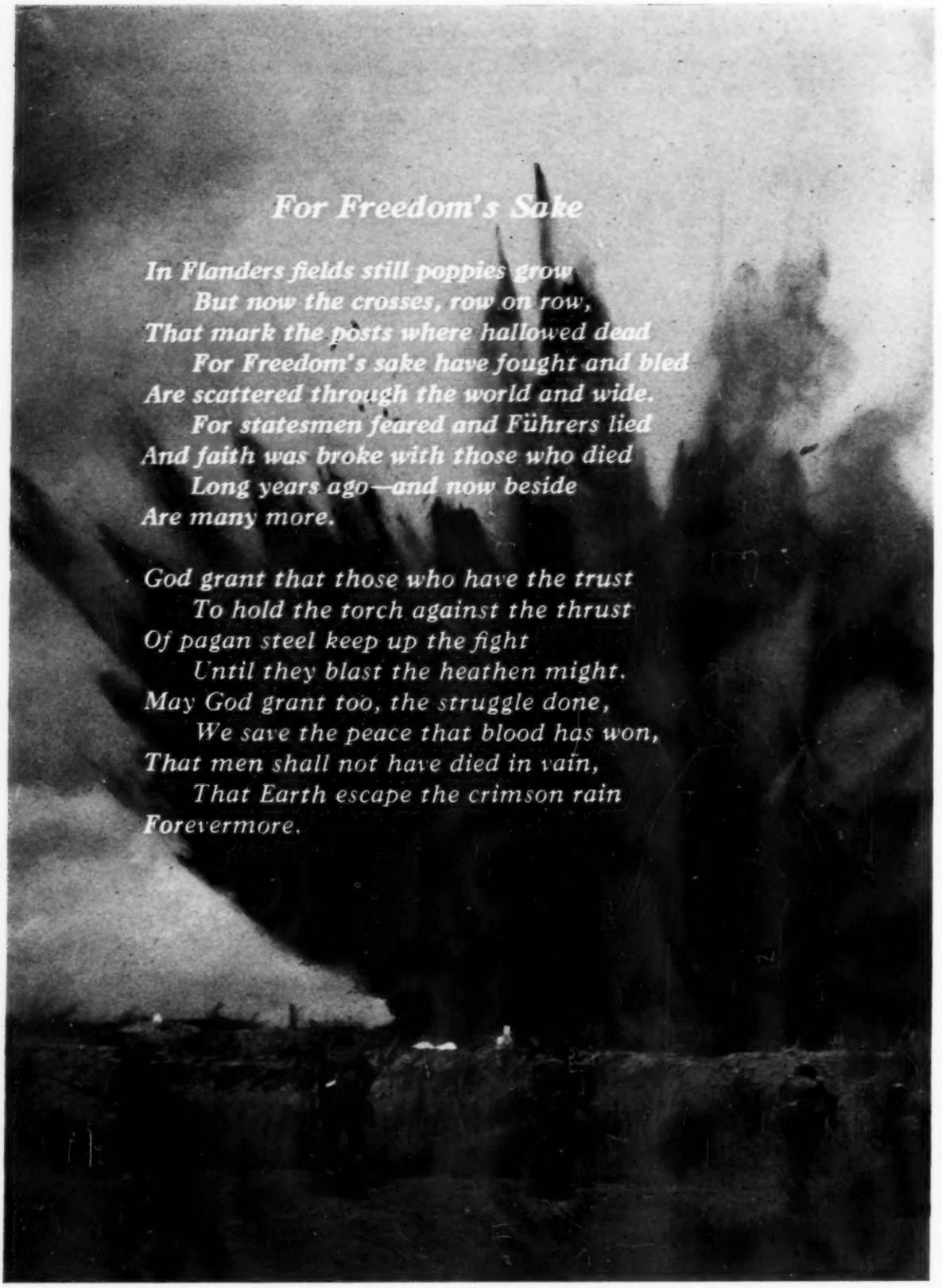

For Freedom's Sake
In Flanders fields still poppies grow
But now the crosses, row on row,
That mark the posts where hallowed dead
For Freedom's sake have fought and bled
Are scattered through the world and wide.
For statesmen feared and Führers lied
And faith was broke with those who died
Long years ago—and now beside
Are many more.
God grant that those who have the trust
To hold the torch against the thrust
Of pagan steel keep up the fight
Until they blast the heathen might.
May God grant too, the struggle done,
We save the peace that blood has won,
That men shall not have died in vain,
That Earth escape the crimson rain
Forevermore.

Dedicated to the memory of Lieut. Col. John McRae whose poem "In Flanders Fields" was the inspiration for the above verse by Brig. Gen. R. H. Somers, U.S. Army, Ret. (Signal Corps photo).

ARMY ORDNANCE

Volume XXV JULY-AUGUST, 1943 No. 139

Naval Armament

The Sea and Air Weapons of Our First Line of Defense

Rear Adm. W. H. P. Blandy

WHILE there is a great similarity between the ordnance requirements of our Army and Navy, so much so, in fact, that the two services use in common many weapons and types of ammunition which one service or the other by mutual agreement designs and produces for both, there are many which must meet widely different conditions and uses.

The entire assortment of naval ordnance of today is a far cry from what was meant by the term in the sailing days when you loaded your smoothbore guns with black powder and round shot and boarded your enemy with cutlass and pike, pistol and dirk. You aimed your guns in those days by "sighting down the line of metal." You fired on the uproll to cut your enemy's spars and rigging if you wanted to take his ship as a prize; and on the downroll into his hull if you wished to sink him. Today, naval ordnance comprises guns of all calibers—from half an inch to 16 inches and weighing from 100 pounds to 100 tons; their mounts ranging from a slender pedestal of 300 pounds to an armored 3-gun 16-inch turret weighing as much as a whole destroyer; projectiles of all types—armor-piercing, antiaircraft, incendiary, illuminating, shore-bombardment; fuzes and high explosives for bursting these shells which are discharged from the guns at great velocity by smokeless powder in metal cases or silk bags, some now made from discarded silk stockings.

Naval ordnance also includes hoists and rammers to bring the ammunition from the shell rooms and magazines and load it into the guns; rangefinders, computing, transmitting, and receiving instruments, and gun directors for directing the gunfire accurately to the target. It includes also heavy armor, some of it thicker than the diameter of the 16-inch shell it must keep out; torpedoes for destroyers, cruisers, PT boats, submarines, airplanes; bombs and bombsights; mines of various types; depth charges and their projectors; nets and booms for protecting naval anchorages; flares and rockets and other pyrotechnics. In other words, naval ordnance includes everything in the Navy which is thrown at the enemy by ships and naval planes, the weapons which do the throwing, instruments for improving their accuracy, and many of the protective devices to parry the enemy's blows. And it has extended its field from the surface of the sea to hundreds of feet below the surface and thousands of feet above it.

Perhaps before going on to the uses of naval ordnance you might like to know something of the Navy's organization for obtaining it. The Bureau of Ordnance in the Navy Department, with 800 officers and 1,500 civilians, is charged with the design, procurement, production, issue, maintenance, and efficiency of all offensive and defensive arms and armament for naval ships and naval aircraft. It procures, largely from the Army, all ordnance for the Marine Corps except their hand arms. It furnishes guns and ammunition to vessels of the Coast Guard and the Merchant Marine, and to Army transports. We are also currently engaged in providing certain quantities and types of ordnance for the naval and merchant vessels of Great Britain and other countries of Europe and South America.

Fifteen naval ordnance plants, eighteen hundred prime contractors, and twenty-five thousand subcontractors produce this seagoing armament. Guns are tested at proving grounds, then sent to shipyards for installation aboard ship, together with their fire-control systems. Ammunition is delivered to thirty-three depots and magazines, a few large ones being in the interior for greater isolation and security, but most of them located on the coasts. In these ammunition depots, final assembly and loading of the larger calibers is performed, and all types of ammunition are issued to our ships.

LET us now consider the weapons themselves and how they are used, beginning with naval aircraft weapons. I am not going into the use of aircraft machine guns, for they did not originate with the Navy and are seldom used against ships except for strafing incidental to attack with bombs or torpedoes. So we will begin with the bomb. If you are going after a battleship, you've got to use an armor-piercing bomb if you really expect to sink her, for the modern ship of that type has a protective deck about half a foot thick over her vitals, and the tops of her gun turrets are just as heavy. The usual "general-purpose" or demolition bomb, with a thin case and a lot of explosive, just won't do the trick. I've seen a turret top which had been hit with such a bomb. The only repair equipment needed was a paint brush and nobody inside the turret was injured except the turret officer whose ear was scratched by the periscope, the upper part of which was thrown back violently by the blast of the explosion.

To get through heavy armor, a bomb, like a shell fired from a gun, must be specially designed for the job. The principal features are a delayed-action fuze, a very thick wall and heavy nose, and, consequently, a small bursting charge. It must, of course, have plenty of striking velocity. The latter can be achieved only by dropping from high altitude, or by diving at extremely high speed. In either case, accuracy is difficult to achieve. In fact, high-altitude level bombing has proved almost useless against ships maneuvering in the open sea at high speed. Lower altitudes, however, produce results, but against well-armed ships we must be willing to accept correspondingly heavier plane losses from antiaircraft fire. Even at medium altitudes, to bomb a point

Admiral Blandy is Chief of the Bureau of Ordnance, U. S. Navy. This article is based on an address of the Admiral before the Economic Club of Detroit, Mich.

U. S. Navy

THE PATROL BOMBER HAS LENGTHENED THE RANGE OF THE NAVY'S STRIKING POWER

target like a ship accurately in horizontal flight requires a precision bombsight. The Norden bombsight is still the finest sight of this type known. It was designed by Mr. Carl Norden, who was born in the Dutch East Indies, and was developed jointly by Mr. Norden and the Navy's Bureau of Ordnance, which has always been the sole customer of the Norden Company. The Bureau furnishes this sight to both Army and Navy aviation.

While light-case bombs cannot sink a battleship, they can seriously damage her communication equipment, exposed fire-control stations, the lighter antiaircraft batteries, and can pierce the light upper decks and start fires. The same bombs can sink lighter types of naval vessels and, of course, transports and cargo ships. Against the latter types, if unarmed or poorly armed, the bombs can be delivered on board by "masthead" bombing which is just like dropping a message on the deck, though considerably less polite. The Germans used this method with great success in the early part of the war against unarmed British merchant ships. But when the British started putting 20-mm. antiaircraft machine guns on their merchant fleet, the Germans discontinued this method, as it became very unhealthy.

THE best plan of attacking *well-armed* ships with bombs at short range is by dive bombing. Of course you must have planes specially built for it, or they will not stand the terrific stresses of the pull-out. The planes push over at altitudes high enough to afford fair protection from the ships' guns, take advantage of cloud cover or a brilliant sun if available, and come down "like a bat out of hell" at an angle as steep as seventy degrees in the final dive. The maneuvering of the target ship interferes considerably at times, but a good pilot can take care of it. The percentage of hits is usually much higher than in level bombing at high altitudes. So also is the percentage of plane losses, though much less than the low altitudes reached would indicate. The ship's gunners are firing with the guns elevated to difficult and awkward angles, the sun may be in their eyes, the ship is probably swinging violently, heeled over and maybe rolling. Theirs is not an easy job.

The man who has had the best box seat at a dive-bombing performance so far is Ensign Gay, whose torpedo plane was shot down in the Battle of Midway. He lay in the water with a seat cushion over his head for camouflage when the YORKTOWN dive bombers came in. He saw these planes strike hard and most effectively at three Jap carriers close by him. Both the KAGA and the AKAGI, between which he lay, were hit repeatedly, the planes on deck which they sought to launch being set afire until both ships burned furiously from stem to stern. The carrier SORYU, already damaged, was hit again, and her bonfire burned more brightly. So many hits were made on these carriers that the later pilots coming in saw that they needed no more attention and favored other targets with their bombs. As a result of this dive-bombing attack, all three of these Jap carriers were destroyed, two battleships were hit, one of them being set afire, and one light cruiser or heavy destroyer was hit with a 1000-pound bomb and believed sunk.

BUT to sink ships, it's always better to let water into them instead of air. That's where the torpedo comes in handy. You know what Farragut said about them. Probably our new manufacturers have echoed that great admiral's remark! I know I have, more than once. For a torpedo, while the deadliest weapon of the sea, is also the most difficult to make, maintain, and adjust. But this is not so surprising when you consider what you're asking of it. You have heard of "two-man submarines." Well a torpedo is literally a "no-man" submarine, and it is dropped from the air at such heights and at such speed as would break every bone in a man's body and make a mass of junk out of a car or an airplane. Yet the 5,000 parts and intricate assemblies of the torpedo must take this beating and then propel and control and explode this underwater hellcat as if launched from a barge or pier.

After its initial dive, the torpedo must take and hold the exact depth previously set on the index. This might be ten or twelve feet for a destroyer or light cruiser but much deeper for a battleship, for this Goliath must be hit below the belt—the armor belt—or you won't hurt him much. This educated "tin fish" must generate its own power, using the expansive force of compressed air, steam, and gases from

burning alcohol fed into a turbine engine. Two propellers, both on the centerline, turn in opposite directions to keep the torpedo from rolling over to an angle which would interfere with its depth mechanism. Next, the torpedo must steer a straight course with only a gyro for a helmsman. The final duty of a torpedo is to explode when it hits the target, and not before, such as when it first hits the water.

The last naval air weapon which I shall mention is the antisubmarine depth bomb. This first cousin to the destroyer and subchaser depth charge of the last war is given a far wider range of usefulness now that it also has taken to the air. Like the depth charge, the bomb can be set for any depth desired and explodes by hydrostatic pressure when that depth is reached. I think submarine men will agree that this bomb used by the airplane, with the pilot's wide horizon, his "plan view" of the sea, and his ability to strike swiftly, once a contact is made, is one of their greatest hazards. Both depth bombs and depth charges must explode only a few yards from the tough hide of the modern sub in order to deliver a death blow. But at greater than lethal distances, serious and even disabling damage can still be done to lighting equipment, hydroplanes and rudders, batteries, fuel tanks, and instruments—and it doesn't help morale.

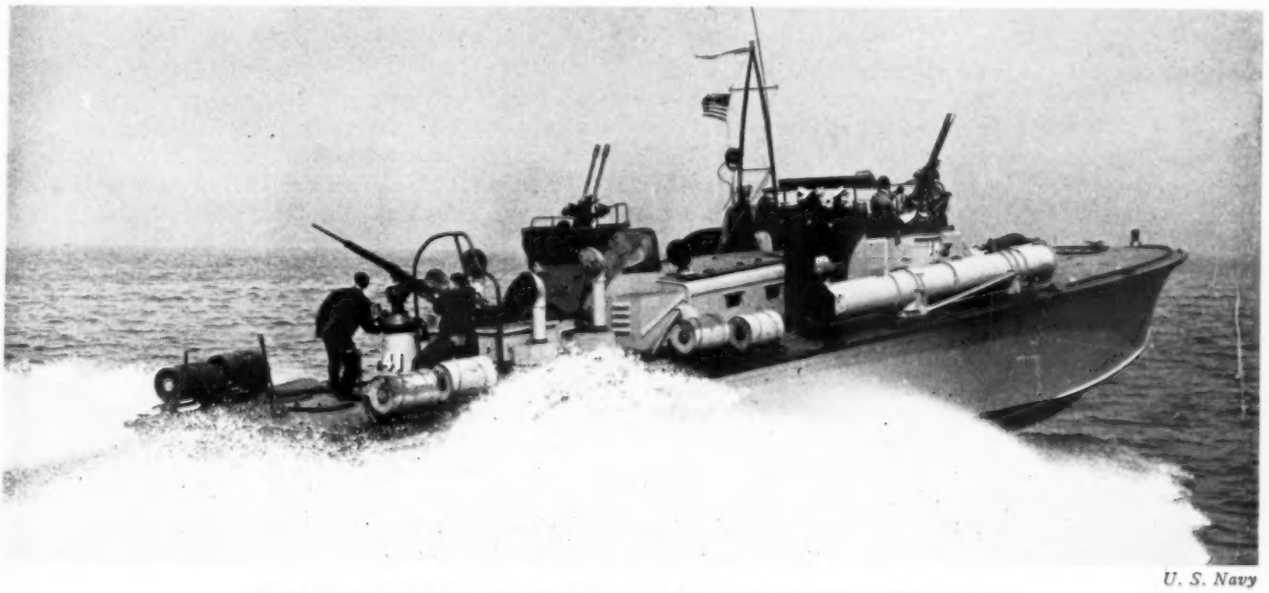
Submarine torpedoes are much like those used by aircraft, but they are larger and don't have to be "beefed up" to stand the blow due to dropping from a height. They are discharged from the submarine's tubes, both in the bow and in the stern, by compressed air. The sub can either throw them straight, or pitch some fancy curves. Curved or angle shots are accomplished by setting the gyro for the final course, and then firing the torpedo with the rudder locked right or left until that course is reached, when the rudder automatically unlocks and the gyro takes control.

A weapon closely akin to the torpedo is the naval mine, which today is one of the most ingenious destructive devices known. Weighing up to a ton and exploded in numerous ways by the influence of a passing ship, mines may be laid by surface ships, dropped by planes, or pushed from the torpedo tubes of submarines. Some are of contact type, some magnetic, some acoustic, and some are detonated from the shore by electric cables. The magnetic mine, contrary to popular belief when the Germans introduced it early in the war, is not drawn like a magnet to the ship's side; the mine stays on the bottom. The magnetic field which surrounds the ship sweeps past the mine as the ship passes over it, generates a current in its firing device, and explodes the charge. The countermeasure is "degaussing," or passing current through coils wound around the ship to neutralize or nullify its natural magnetic field.

PASSING now to the weapons of surface ships, we find the destroyer, PT boat, destroyer-escort vessel, and light cruiser also using torpedoes. Since these ships cannot submerge and cannot muster the swiftness of attack of the airplane, they usually take advantage of darkness, mist, or artificial smoke screens to press home their attacks and to cover their retirement. They fire their torpedoes from deck tubes with a charge of gunpowder, but once in the water, the torpedo, like its mates in the submarine and air services, is "on its own" for both power and control. The depth charge, already mentioned as originating in the last war, is still a favorite weapon of the destroyer and the escort vessel. It has ended the career of many a promising young Axis submarine in both the Atlantic and the Pacific.

Turning now to gun batteries, the 6-inch rifles of our modern light cruisers have no equal in the world for fast, accurate shooting and reliability. These weapons are mounted in five 3-gun turrets, and fire shells weighing something over 100 pounds. You know what the BOISE's guns did in the famous night action off Guadalcanal. A more recent action in which another cruiser took part in a bombardment of a Japanese base brought forth the following comment from the ship's gunnery officer:

> This ship has to date participated in three bombardments and one minor surface engagement. In each of these actions approximately 1,000 rounds of 6-inch have been fired. The guns themselves and their recoil and rammer systems, hoists, etc., have, with few and minor



U. S. Navy

THE SPEEDY PT BOAT IS A FLOATING ARSENAL OF NAVAL ORDNANCE

The swift little fighter above is armed with antisubmarine depth charges, torpedoes, a 20-mm. antiaircraft machine cannon and four twin-mounted cal. .50 antiaircraft machine guns. Patrol-torpedo boats of this type did much damage to Japanese shipping in the Philippines.

exceptions, demonstrated that they are well and strongly built and can be thoroughly depended upon to put out projectiles as fast and as long as is necessary. The control equipment likewise has performed excellently. We who fight with ships are perhaps too prone to accept our weapons as being good, without appreciating the research, the work, and the all-out effort involved by those who make them. I, for one, would like the Bureau of Ordnance and the civilian contractors involved to know that we in this ship feel that our material is better than the enemy's. It is not only quick-firing but has proved rugged and dependable. How rugged and dependable is evidenced by the fact that 1,000 rounds were fired in approximately 10 minutes of continuous fire. There was not a single matériel failure or derangement of equipment during the action.

WHEN cruiser meets cruiser, it's just as well to have a few of the heavy type in your line-up. A 10-gun salvo of 250-pound armor-piercing shells from one of these ships polished off the Jap cruiser which was firing on the Boise and which might have sunk that fine ship and her gallant crew. These heavy-cruiser 8-inch guns, like the light-cruiser 6-inch, are also useful for shore bombardment. All shells used for this purpose have thin walls, correspondingly large explosive charges, and instantaneous impact fuzes. When the Marines landed on Guadalcanal and Tulagi last August, both heavy and light cruisers and destroyers used their batteries against shore objectives, just like land artillery, in preparation for the infantry assault which followed. Planes also bombed these targets most effectively. But when you can get ships into position for bombardment, they have the advantage of continuous fire, while a plane, after dropping its bombs, must go back to its field or carrier and reload. But even without bombers, you need plenty of fighter planes to help the ship keep her position, if there is enemy aviation present, and spotting planes are of great assistance in directing the ship's gunfire.

One report from a Navy petty officer on the Solomons landing brought home to me the complex nature of modern war more than any official battle record by a fleet commander has done. This man, a coxswain, had charge of a tank lighter which was proceeding in to the shore with a tank. He wrote: "There was plenty of machine-gun fire as we got close to the beach. Just then a Jap plane showed up on the port bow and looked like it would pass close to us. I put my rudder over to swing the lighter so the tank could fire its antiaircraft gun. I don't know if they hit him, but those Marines sure came close!" An Army tank, manned by Marines, is maneuvered by a sailor to fire at a plane! And you see plenty of similar incidents in the South Pacific. The Army, the Navy, and the Marines—air forces, sea forces, ground forces—work and fight together down there as if they were one service. They wear the same uniform, except for service and corps insignia. And whatever their separate shortcomings may be, they're a combination hard to beat.

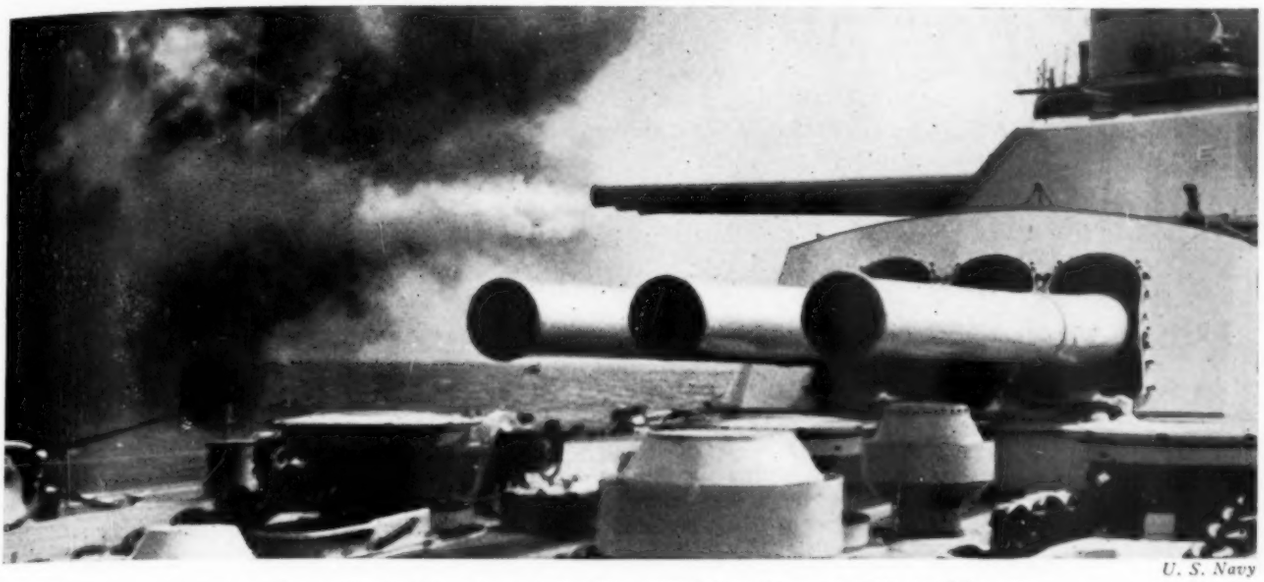
The most powerful engine of destruction used at sea is still the big gun of the battleship. Of 16-inch caliber, weighing about a hundred tons, firing one-ton projectiles which travel half a mile a second to a distance greater than twenty-five miles, and hitting a moving ship with far greater accuracy than a high-altitude bomber can achieve, the latest United States battleship main-battery gun has shown itself well worthy to retain its place on the naval team—and so has the ship which carries it into action. The battleship is not a fixed type. It is the embodiment of a principle—the principle that there must be, in a strong navy, a type of ship which combines the greatest power of offense with the greatest power of survival. The ship which embodied this principle in the days of sail was the ship-of-the-line, with as many as 120 smoothbore guns, and tough oak timbers as her side armor. Next came the early ironclads, with guns still sticking out of fixed gunports. Then, in the Spanish-American War, came the turreted ships of Santiago Bay.

Today you see the same principle in the North Carolinas and Iowas, faster, tougher, harder-hitting fighting ships than the world has ever seen before. Never a demon for speed, the battleship of today nevertheless is fast enough to go along with the carriers, cruisers, and destroyers. Unable to strike swiftly at a range of 200 miles, like the carrier with her planes, she can hit harder and longer than the carrier, and is much harder to sink. The battleship commanded by Captain Gatch easily survived the identical type of attack which sent the Prince of Wales to the bottom, and she shot down thirty-two Jap planes in the process. She also helped to defend the carrier which was in the same formation with her and which might easily have suffered the fate of the carriers which we have lost, without this added protection. Then she went into a night action and with a sister ship and a few destroyers sank nine ships—battleships, cruisers, and destroyers—in only a few minutes of actual firing. The captain of her sister ship said, "Our fire control and the effectiveness of our ammunition exceeded our expectations."

It is only forty years since naval gunners thought they were doing pretty well to be able to hit a stationary target the size of a ship's hull at 4,000 yards. In this war, the Bismarck destroyed the Hood with her second salvo at 23,000 yards, and we did even better off Casablanca where one of our battleships registered hits on the Jean Bart with her first salvo at 26,000 yards and put her out of action with her second. The devices which enable a pitching and rolling ship in rapid motion to strike an enemy also in rapid motion hull-down over the horizon, and with the wind blowing a zephyr or a gale from any point of the compass, are often as incomprehensible to naval officers out of touch with current progress as they are to laymen.

THE process of laying guns for long-range fire involves all sorts of abstruse data, such as courses and speeds of firing ship and target, wind velocities and barometric pressures, powder temperature, and even an allowance for the rotation of the earth during the flight of the projectile. But all these data are incorporated into the problem almost automatically and in amazingly brief time. A fire controlman in the foretop operates a sort of super gunsight called a director which follows the target and transmits the data electrically to a plotting room well below decks where highly complex instruments evaluate all variables involved, mostly automatically, and transmit them electrically to the turrets. With this system, it is not necessary for the men at the guns to see the enemy ship at all.

One recent writer has spoken of the naval gun as something which has about reached the limit of its development. He is, of course, all wrong when it comes to our smaller automatic and semiautomatic guns, and even in the case of our big guns their *effectiveness* has increased steadily even though they have not themselves changed much in character in the last twenty years. The story of fire-control develop-



U. S. Navy

THE BATTLESHIP'S BIG GUNS ARE STILL THE MOST POWERFUL NAVAL WEAPON

ment is one of the romances of naval history, and, far from being completed, it is one of the hottest subjects of the day. The biggest problem which we have had to meet in this war is that of improving our antiaircraft fire control, and, while we still have a good way to travel, you would be amazed at the degree of progress we have already made.

You will note that I call the battleship gun the most powerful naval weapon; I did not say the most useful. The most useful weapons, or at least the most used, are the airplane bomb and torpedo, the submarine torpedo, the depth charge, and the antiaircraft gun. Our battleship big gun has thus far seen little day action in this war. You can blame the Japs for that. They are not inclined to engage in a battleship fight. We have forced action on them at night, by surprise. But in daytime, their planes spot us, and they change course away so that they can only be struck by our planes. One should remember, though, that a gun does not always have to fire to prove useful. Its apparent idleness may result from its acknowledged ability to conquer. It is, of course, far better to sink the enemy ships than to frighten them off, but the latter effect may often serve a good purpose, too. The Japs finally retreated from Guadalcanal and in effect forfeited the island because they knew they could not match our firepower. And you can count on Admiral Halsey to bring his battleships' big guns to bear upon the enemy in daytime, too, before this war is over.

The battleship will, of course, still further evolve. She may turn into a tough carrier with no heavy guns. She may even leave the sea—if and when all other ships do—and then men will see battleships of the air. But until then there will always be some type of ship upon the ocean incorporating the battleship principle which is that of the maximum combination of hitting power and staying power.

THE final category of naval weapons which I wish to tell you about are the antiaircraft guns. Though only defensive, and therefore not likely to win decisive battles, they are of vital importance today in keeping our ships afloat to use their offensive arms. The best defense against enemy aircraft is to take the offensive with fighter planes, for you must never let the enemy feel entirely immune to attack until he comes within range of your ship's guns, any more than you would be content to have just the locks on your doors and windows, and perhaps a pistol in the house, as your sole defense against burglars. The fighters are, therefore, your police force. They can reach out for the enemy planes, close the range to point-blank and keep it there until the business is finished. Result—a high percentage of hits and a heavy toll of enemy aircraft. A ship, on the other hand, must wait for the attacking planes to come to her and must fire at much longer ranges than the fighter and at rapidly changing ranges. Nevertheless, fighters are not always present when enemy planes attack; and even when they are, they seldom bring down the whole flight. So there is usually plenty of work for the ship's guns, too.

The heaviest U. S. naval antiaircraft gun is the 5-inch. With its accurate and rugged fire-control system, it has been proved by actual battle results to be the best in the world for rapidity and accuracy of fire and effectiveness of ammunition. Its high-explosive shell, burst by a time fuze, takes good care of any horizontal bombers which come low enough for accurate bombing and helps out the defense against dive bombers, torpedo planes, strafers, and other close-flying planes. But the 40-mm. and 20-mm. are the better guns for this in-fighting. Both of these guns also use explosive ammunition but with sensitive contact fuzes. The 40 is mounted in twin and 4-barreled mounts, the 20 in singles, and both are plastered all over the topsides of our ships. I can't tell you the exact number of these guns a particular ship carries, but I am certain you would be astonished if I did. Together with the powerful 5-inch batteries, the collection of these guns on each of our new big ships—battleships and carriers—constitutes the heaviest concentration of antiaircraft guns in such a limited space found anywhere in the world.

Even before Captain Gatch's famous "battleship versus plane" action, which I have already mentioned, another of our new battleships, attacked by more than 30 planes—horizontal, glide, and dive bombers, and torpedo planes—put up such a heavy fire that officers on nearby ships thought she had been hit and was burning. She actually was not hit at all, and shot down about one-third of the attacking planes. Some of the others jettisoned their bombs at high altitude,

refusing to enter her 5-inch barrage or approach close to her deadly automatic guns.

The big battleships and carriers have not received all our attention to antiaircraft improvements. The new cruisers, destroyers, escort vessels, PT boats, subchasers, tenders, repair ships, transports, and even cargo ships, of both the Navy and the Merchant Marine, have powerful and accurate antiaircraft batteries which really knock planes down. The defense is not perfect, of course. We have lost ships, and we will lose more, by bombing and torpedoing from the air. But these guns have enabled fleet commanders to take risks which would have been unthinkable two years ago; they have saved many a ship and its crew and many a precious cargo from total destruction.

I COULD spend the rest of the day telling stories of the accomplishments of these guns and their valiant gunners. On all types of ships they have had success, but I am always pleased most by the astonishing results frequently achieved by them on transports and freighters. In the early days of the Solomons campaign, a convoy of these vessels, escorted by cruisers and destroyers, was passing near the shore of Guadalcanal. A combined Jap force of 40 land-based bombers and torpedo planes attacked this convoy. Results, one destroyer torpedoed but not sunk; one transport set afire by a crashing plane and later abandoned; 14 Jap planes shot down by antiaircraft guns of both the escort and the convoy itself. A dozen more were brought down by fighters just before and just after the attack was delivered; several others were seen to be damaged. Only half a dozen planes came out undamaged.

Possibly you read recently of the Liberty Ship MOULTRIE, one of 2,500 merchant ships, American and allied, provided with U. S. Navy guns so far. For a week the convoy in which she sailed was under almost uninterrupted attack from Nazi planes and submarines. At every alert the armed guard unit manned the ship's guns and put up so effective a barrage that when the attacks ceased on the eighth day the MOULTRIE's crew had destroyed a total of eight German planes and had scored hits on twelve others. The MOULTRIE was not damaged.

Guns on merchant ships seldom get a crack at a sub. But they usually force the subs to use torpedoes, for these undersea craft seldom like a surface fight. An exception was an American freighter torpedoed a few months ago by a Japanese submarine. The Jap skipper made the mistake of surfacing in order to complete his kill. The Navy armed guard crew opened fire and scored two direct hits, which was more than Yamamoto's pigboat could take. The freighter is back in service, but the sub lies on the bottom due to the deadly effectiveness of the cargo ship's 3-inch gun.

I do not wish to give the impression that everything we have in naval ordnance is perfect, and that production has, without a single exception, always been up to or ahead of requirements. When you must do all your designing and testing in time of peace, it would be a miracle if everything you made came through the acid test of actual battle with flying colors. And when you consider how late the country really got down to the business of arming, it's not surprising that we have not always had all we wanted of everything. But I *can* say, taking all types of naval ordnance together, that we do not have to take our hats off to any other navy for either quality or quantity. This statement applies to what was manufactured before the war, and it certainly applies to what is being made now by industries which, three years ago, never dreamed of going into the ordnance business.

In evaluating the various types of weapons used both by the ships of the sea and by the ships of the air that fight against them, I hope you will adopt my philosophy of keeping an open mind about the old and the new. We have seen far too extravagant claims made by overenthusiastic proponents of new weapons, especially new air weapons. We have also seen far too much conservatism in giving up or modifying old weapons and conceding the value of the new ones. I can assure you that no officer in the Navy today, in a position of authority and power, fails to realize the full value of the arms of the air. On the other hand, it is easy to be so impressed with these weapons that we overlook the tremendous strides being made in the defense against them.

I have read commentators who point out that the Pearl Harbor attack, the sinking of the PRINCE OF WALES and REPULSE, and the magnificent victory of land-based planes over the Japanese convoy and its escort in the Bismarck Sea prove that the air forces are now supreme over the sea forces. They prove no such thing. Pearl Harbor proved the tremendous surprise value of aircraft and their effectiveness against ships and a base which were not armed and equipped and warned as they are today. The loss of the PRINCE OF WALES proved that that particular ship, armed as she was at that time, could not, without the aid of fighter planes, stand off the determined and aggressive attack of the aviators the Japanese Navy had at that time—well-trained and ready to go through any amount of fire to accomplish their mission. The Bismarck Sea action proved that well-armed aviators (mostly of our Army Air Forces), well-trained in proper tactics and possessing a strong will to win, could knock the spots out of most of the Japanese planes present and sink a convoy of unarmed or poorly armed merchant-type ships, escorted by Japanese destroyers and possibly a couple of small cruisers. The escort was inadequate, and Japanese antiaircraft fire is notoriously bad compared with ours.

ON the other side of the ledger I already have given cases where our ships, sometimes with and sometimes without the assistance of fighter planes, have knocked hell out of a Jap air attack with little or no damage to themselves. There are cases in between where the Japs have inflicted heavy damage, sinking one of our carriers, or perhaps a cruiser or destroyer or transport, but with the loss of practically their entire attack force.

So you must consider *whose* air force and *whose* navy took part in an action, and the stage of the war, before you draw general deductions upon the relative merits of air weapons and ship weapons. And then when you have drawn them, you must be prepared, when something new happens tomorrow, to admit that you were wrong today. I can assure you that in my Bureau, where we are responsible for the development and production of weapons for both planes and ships and where we have the advantage of full and complete information upon all battles, we try to plan and design weapons only after weighing every bit of experience available. And while we must predict to some extent the weapons to be used tomorrow, we do not attempt to fight this war with the weapons of Buck Rogers in the twenty-fifth century!

EDITOR'S NOTE.—At a recent news conference, Admiral Blandy revealed the development of a new projectile which will enable 16-inch naval guns to be used against aircraft.

Ordnance in the Canadian Army

The System of Development, Supply, and Maintenance of Munitions

Maj. Gen. James V. Young

THE INTENT of this article is, first, to give a short historical background of ordnance in Canada and then to follow through military supply operation from the time of a General Staff decision as to what is required, to the repair of equipment after battle. It is, in all its detail, a complicated chain of events reaching deep into the total efforts of the nation.

The historical development of ordnance goes back some eight centuries to the year 1181 and is rooted in a conference called the "Assize of Arms" held at Winchester, England. This strange meeting of English noblemen laid down the first equipment scales for the Army—what one could call the first of all mobilization store tables. The "Assize" coördinated the work of the "master smiths" and "master bowyers," as well as the manufacturers of suits of mail and the then-known fighting weapons—thereby creating the first war factories and workshops.

In those days, the whole British Army was not much stronger numerically than one division of today's armies, and yet it is significant to note the importance attached to the problem of supply, in that there should be one special organization for the purpose. History tells, too, that the battle of Crécy in 1399 was won by the bowmen who acted rather like modern infantry following up the break-through made by the *Panzer* division of the day—the heavily armed cavalry. In spite of the years between 1181 and 1399, it was the Assize of Arms in Winchester, the birthplace of British Ordnance, which created the means for the bowmen who fought at Crécy to obtain their bows and arrows and for the cavalry to obtain its heavy trappings of mail for both horses and men.

The first true Ordnance appointment occurred in 1299. During the reign of Edward I there was created the appointment of an "Artillerator" or "Attilator" as guardian of the King's Wardrobe (Armory) in the Tower of London, charged with responsibility for the manufacture and repair of all engines of war—the cumbersome slings and catapults which were used in sieges before the introduction of guns—and also for purveying various military stores to the King's troops. The "Artillerator" (from which comes our word "artillery") was the forerunner of the Master of the Ordnance.

Bows and arrows did not long remain the chief armament of armies; cannon now came into use. Almost coincident with this change, the title, "Master of Ordnance," first appeared in the year 1414. In actual fact, the name in full was bulky to a degree, the holder being called "Master of Our Works, Engines, Cannons, and Other Kinds of Ordnance for War." The first "Master of the Ordnance" was one Nicholas Merbury, commissioned by Henry V. In the following year, 1415, Merbury accompanied the King to France and, in his capacity, supervised the siege operations at Harfleur, later taking part in the Battle of Agincourt. Thus the term "ordnance," derived from the title of an officer of the Court of King Henry, has come to be used throughout the armies of the United States, Great Britain, and Canada. The word "ordnance" itself finds its derivation from the ordinances or decrees promulgated by the King in order to regulate the size and bore of cannon.

The title, "Master General of the Ordnance," came into being in the year 1664 during the reign of Charles II when a Board of Ordnance for the British Army was created, headed by a chief officer known as the Master General of the Ordnance. This office has been occupied by some of Britain's ablest military administrators. A direct ancestor of Prime Minister Winston Churchill, the Duke of Marlborough, filled this post during the early part of the eighteenth century. After the defeat of Napoleon at the Battle of Waterloo in 1815, the Duke of Wellington returned to England and was appointed to this office, which he held from 1819 to 1827.

The Royal Canadian Ordnance Corps traces its own historical development from the time of the formation of a Canadian Militia in 1775. The evolution of the Royal Canadian Ordnance Corps has at all times, however, been associated closely with the Royal Army Ordnance Corps of the British Army, and the history of the Royal Army Ordnance Corps bears directly on that of the Royal Canadian Ordnance Corps. The British Army traces the lineage of its Corps to the year 1475 at the time of the last medieval expeditions against France. History records that the only soldiers on that expedition garbed as "King's Men," that is, those who wore what we now call uniforms, were the Old-World representatives of the Royal Army Ordnance Corps and of the Royal Artillery and Royal Engineers.

It was the Board of Ordnance created in 1664 which administered the then existing Ordnance Corps of gunners, sappers, miners, and ordnance men who, for generations, were the only representatives of the modern Army. It was the coat of arms of the ancient Board of Ordnance which was taken by the forerunners of the Royal Army Ordnance Corps, and when the Board, having served its purpose, passed away after the Crimean War, the coat of arms was adopted by the British War Office.

A CANADIAN period of independent development in relation to the Ordnance Corps began in 1855. Before that date, the Canadian system of supply stemmed from the British system, whereas after that date it either paralleled or, in some ways, modified the British system to its own particular needs. The close ties which exist between British and Canadian services can perhaps be more readily appreciated by the knowledge that, for roughly one hundred years before 1855, Canadian needs were supplied by British Ordnance depots in Canada with stores manufactured mainly in England.

The first Canadian ordnance services established in 1855 were civilian in aspect, rather than military, and were supervised by a director of stores. The first real project undertaken

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General Young is Master General of the Ordnance, Canadian Army. A chart showing the organization of the Master General of the Ordnance Branch is published on p. 89.

in Canada by an ordnance service as such was the outfitting of Canadian troops for the expeditions which suppressed the rebellion in the Canadian Northwest.

The early part of this century saw a new phase in the evolution of the Corps. First came the withdrawal of British garrisons from Canadian coastal stations. With the commencement of this withdrawal came the formation of an Ordnance Store Corps, patterned on British Ordnance and, for the first time, organized on a military basis. Uniforms and badges were modeled on British Ordnance. With the departure of British troops and ordnance services arose the immediate need of replacement of trained personnel. Canada now required its own armament artificers and ammunition examiners. This compulsory acceleration in the growth of Canadian ordnance services stood Canada in good stead since it enabled her to find trained men in her own forces and helped her to prepare for the years from 1900 to 1918.

The South African War in 1899-1901 was the first full test faced by Canada in the matter of supply. Six thousand men were equipped for overseas service. Following this came the decade prior to the first World War during which Canadian ordnance services moved a further step forward. The Ordnance Store Corps now became known as the Canadian Ordnance Corps.

Coincident with the commencement of war in 1914, the basic organization built up in the period immediately preceding was greatly expanded and grew to maturity in meeting the demands placed upon it. In recognition of the part played by the Corps in the Great War of 1914-1918, His Majesty, George V, granted permission to it to be known as "The Royal Canadian Ordnance Corps."

The greatest strain on Corps organization came with the declaration of the existence of a state of war on September 10, 1939. Along with the consequent problems of provisioning, distribution, and maintenance, was the problem of trained personnel. The latter, at the time, consisted of permanent-force (regular) soldiers, but this nucleus was soon dispersed due to the need of such personnel overseas. This left a difficult shortage of experienced Ordnance personnel in Canada, but voluntary enlistment closed the gap—men who had been executives and accountants in civilian life quickly grasped the mechanics of supply and distribution of war weapons—engineers, mechanics, welders, fitters—all helped to fill the breach and to lend a hand in the supply and care of complicated equipment and weapons.

THE staff of the Canadian Army is divided into four main branches. The General Staff Branch, in so far as equipment is concerned, decides what is necessary. Theirs is the responsibility of military policy, war organization, operations, intelligence, plans, and training. The Adjutant General's Branch supplies mainly the personnel and deals with its administration. The Quartermaster General's Branch is concerned with engineer services, feeding, housing, and all movement. The Master General of the Ordnance Branch deals, broadly speaking, with research and development, provision, storage, issue, and repair of all equipment, stores, and clothing of the Army.

This broad scope of responsibility of the Master General of the Ordnance comprises the scientific development of material for military requirements, provision, storage, issue of guns, vehicles, arms, ammunition, technical and signal equipment, barrack and general stores, clothing and equipment, as well as their repair and the matter of salvage and disposal. The organization chart of the Branch on page 89 indicates the division of responsibility.

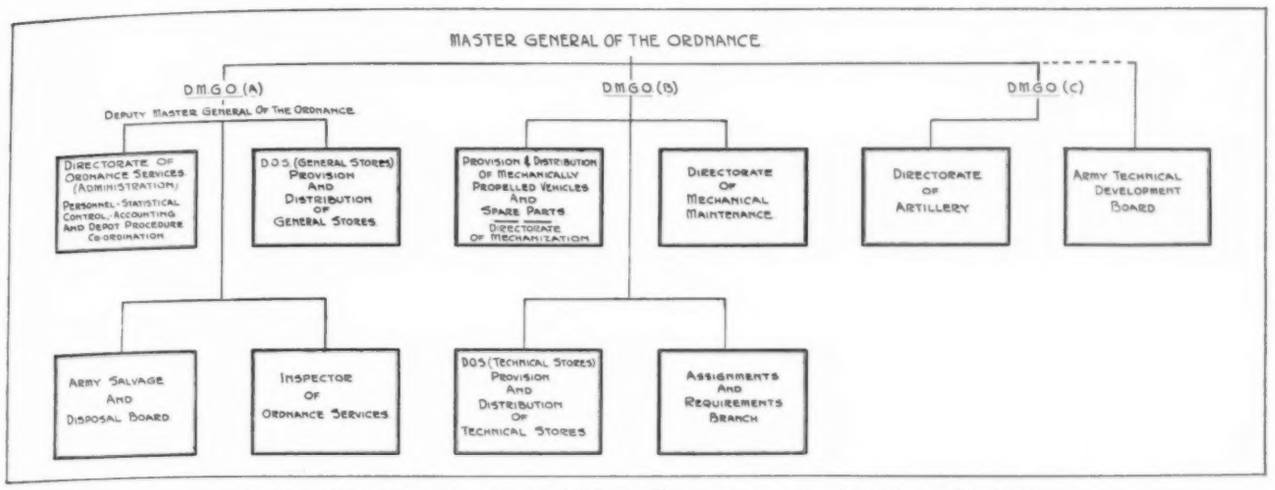
The Branch is grouped under three deputies. One supervises administration, personnel, accounting, provision and distribution of general stores, inspection of ordnance services and the task of Army salvage and disposal. The next, embracing the technical field, covers the provision and distribution of mechanically propelled vehicles and spare parts, of technical stores and their maintenance, and the matter of liaison with the Munitions Assignments Boards in London and Washington. The third deals with research and development. Under each deputy is a series of directorates responsible to him, and consequently to the Master General of the Ordnance. Each of these directorates is known as a "Directorate of Ordnance Services" and operates within a designation of specific duties. Each directorate is headed by its own director, whose immediate responsibility is the discharge, within the scope of his duties, of a certain part of the direct responsibility assumed by the Master General of the Ordnance.

THE Royal Canadian Ordnance Corps, a combatant military unit and a corps of the Canadian Army, carries out in the main, both at headquarters and in the field, the duties vested in the Branch of the Master General of the Ordnance. However, within the broad field of development and research of military equipment, this principle varies in that civilians are employed and, further, in that officers and personnel from other corps of the Army (corps which, in effect, become the ultimate users of the equipment) are seconded to the Branch for this purpose.

Research and development of military equipment is an important feature of the Master General of the Ordnance Branch, and intense effort is made in order to achieve results. To coördinate all such work on behalf of the Canadian Army, the Army Technical Development Board has been created within the framework of the Department of National Defense. The board is not part of the Branch of the Master General of the Ordnance, although it does operate under the chairmanship of the Master General of the Ordnance. The board has been constituted to include representatives of the Army, the National Research Council, and the Department of Munitions and Supply. Its fundamental object is the examination and screening of all major projects as well as the allocation of the agency chosen to undertake their development.

The word "agency" in the field of development applies to the National Research Council and through it to the universities of Canada; it applies also to the Department of Munitions and Supply, and through it to the manufacturers of the Dominion or to other departments of the Government. Finally, "agency" is applicable to certain development laboratories within the Army itself. With the allocation of an agency, the progressing of the development through to completion is accomplished by those directorates of the Master General of the Ordnance Branch particularly concerned. Such directorates all come under the supervision of the deputy in charge of research and development.

The Royal Canadian Ordnance Corps ultimately takes over the host of different items of Army equipment for purposes of storage, distribution, etc. Let us consider, then, how equipment "flows" to the Army, from the original authorization to the final handing over, by the manufacturer, of the finished equipment.


MASTER GENERAL OF THE ORDNANCE
DMGO (A)
DEPUTY MASTER GENERAL OF THE ORDNANCE
DMGO (B)
DMGO (C)
DIRECTORATE OF ORDNANCE SERVICES (ADMINISTRATION)
PERSONNEL - STATISTICAL CONTROL - ACCOUNTING AND DEPOT PROCEDURE CO-ORDINATION
D.O.S. (GENERAL STORES) PROVISION AND DISTRIBUTION OF GENERAL STORES
PROVISION & DISTRIBUTION OF MECHANICALLY PROPELLED VEHICLES AND SPARE PARTS
DIRECTORATE OF MECHANIZATION
DIRECTORATE OF MECHANICAL MAINTENANCE
DIRECTORATE OF ARTILLERY
ARMY TECHNICAL DEVELOPMENT BOARD
ARMY SALVAGE AND DISPOSAL BOARD
INSPECTOR OF ORDNANCE SERVICES
D.O.S. (TECHNICAL STORES) PROVISION AND DISTRIBUTION OF TECHNICAL STORES
ASSIGNMENTS AND REQUIREMENTS BRANCH

ORGANIZATION CHART OF THE MASTER GENERAL OF THE ORDNANCE BRANCH

Following approval by the General Staff of any specific item of equipment, the Master General of the Ordnance Branch, through its directorates, initiates provision action by means of contract demands. These demands are equivalent to orders or requests for procurement.

The Master General of the Ordnance Branch now turns to the Department of Munitions and Supply as its procurement agent. Provisioning in Canada is the responsibility of the Master General of the Ordnance, but procurement is the responsibility of a civilian department of Government—the Department of Munitions and Supply. Before this war, the Master General of the Ordnance was responsible for procurement, but with the expansion of the three services, Army, Navy, and Air Force, it was decided to set up a department of government to which all three services would turn for procurement. It is the Department of Munitions and Supply which deals in Canada with industry; it is this Department which effects all purchases. It goes further in effecting purchases for allied governments in case of Canadian production.

Having regard for problems of labor, materials, locations, and like matters accompanying the distribution of war orders, the Department of Munitions and Supply undertakes the marshaling and coördinating of industry and the placement of orders. The next phase of progress is the actual production, by the manufacturers, of the item in question, with both the civilian department of Government and the Master General of the Ordnance Branch acting in coöperation in order to offer civilian and military assistance to the manufacturer.

Following manufacture, inspection of the completed equipment becomes of paramount importance, and this duty is performed under rigid war service tests by the Inspection Board of the United Kingdom and Canada. This is a joint board which coördinates and assumes responsibility for inspection of Canadian production of Army and Air Force equipment for all goods, whether on Canadian or allied account.

If and when the article passes inspection, it then goes to the Royal Canadian Ordnance Corps for delivery to the troops, thus closing the full cycle of provision and procurement. The item has been authorized, ordered, produced, and now, having been inspected, is ready and available for use.

Storage becomes the next matter in sequence; the equipment, weapons, ammunition, etc. must be stored ready for shipment to the theater of operations. Ordnance uses as the heart of its storage organization a series of central ordnance depots placed at strategic locations across Canada for the purpose of distribution to district and camp ordnance depots. From these main points supplies can then flow to the units and formations. This is the normal method of supply, subject to variation in operational zones in order to conform with field requirements. The actual movement of stores and distribution between depots is controlled by the directorates of the Master General of the Ordnance Branch, although the policy underlying such distribution, in the case of armaments, vehicles, and technical equipment, rests with the General Staff.

STORES may be divided into three broad categories: First, general stores, covering clothing, personal equipment, barrack and camp equipment, antigas equipment, and the mass of general items which are not of technical nature; secondly, technical stores embracing arms and ammunition, signal and wireless equipment, fire-control and searchlight equipment, artillery stores, and similar items; thirdly, mechanical transport, including passenger and load-carrying vehicles, armored fighting vehicles—wheeled and tracked—spare parts, tools, and miscellaneous equipment for all vehicles.

Let us next consider the issue of stores—first with reference to issue in Canada and, secondly, regarding issue to formations in the field.

Issue in Canada involves a flow of supply from district ordnance depots staffed by Royal Canadian Ordnance Corps personnel to particular units. The units and formations are governed in their demands by mobilization store tables, drawn up in pursuance of the individual requirements of all Army formations. Utilizing such tables as the basis of authority, the various units of the Army indent upon district ordnance depots for required stores. Indents are then met by the depots subject to the scale as laid down in the mobilization store table.

Issue of stores in the field necessarily varies from the pattern of issue in Canada. Swiftly changing conditions in the field require a correspondingly flexible plan of supply. Movement of stores to formations and units in the field, as well as all services connected with any part of such movement (including Ordnance) come under the jurisdiction of the Quartermaster General Branch. At each formation headquarters

in the field is an Ordnance officer who is responsible to the formation commander for the efficiency of Ordnance services within the formation. Commencing with a forward unit, demands for any particular type of equipment are passed back to the senior Ordnance officer of the division who in turn consolidates it with other demands and passes it back to a base depot from which shipment forward is made.

An exceptionally high degree of coöperation is required in field operations between Ordnance personnel and personnel having the responsibility of transport. The establishment of Ordnance liaison officers at vital transport points is the normal means by which this coöperation is accomplished. Stores are kept moving forward according to scheduled plan, some going from base depots with the daily rations, others, such as ammunition, moving forward in ammunition trains.

REPAIR becomes one of the prime responsibilities of Ordnance. As in the case of issue of stores, repair is divided into its application to Canada and its application in the field. In Canada, first-line repairs are accomplished by the establishment of small garages, usually with units. Maintenance of mechanically propelled vehicles is furthered by regular visits of inspecting officers who consider maintenance as well as the discovery and correction of weaknesses in design or manufacture. Major repairs are carried out by means of technical and nontechnical workshops located as closely as possible to Ordnance depots.

The work of the technical workshops is concerned primarily with types of equipment of a specialized nature while the nontechnical shops have to do with the repair of clothing, boots, tentage, and other general items. Coincident with repair is the matter of salvage and disposal which has as its purpose the ultimate in reclamation value with respect to all items used by the Canadian Army. Throughout this work, the policy of salvage and disposal offers opportunity for reservicing, repairing, or rebuilding salvaged materials.

Repair in the field follows a basic and simple rule of effecting repairs as far forward as the size of the repair task will permit. First-line repairs are carried out by unit personnel, frequently by Ordnance specialists attached to units. Assisting them in this "first-line" area work are light-aid detachments—highly mobile repair units. As the nature of the repair becomes more difficult, a "second-echelon" repair organization appears, carried out by divisional Ordnance workshops or nondivisional workshops in the case of corps formations. This echelon will generally have to do with overhauling and repairing, plus the replacement of assemblies. When the task has become one involving more serious repairs or complete overhauls, third- and fourth-echelon repair units take over in the form of army Ordnance workshops or base workshops. The whole principle underlying the system is that of highest mobility in the forward areas, with the more difficult tasks being passed back to the less mobile but more thoroughly equipped echelons.

Personnel requirements are effected through establishments approved by the General Staff Branch in consultation with the Branch of the Master General of the Ordnance. Following this, the Branch of the Adjutant General makes arrangements for obtaining the necessary personnel. Army examiners interview every recruit upon enlistment and by interview and aptitude tests decide that arm of the service in which he would be best fitted to serve.

Training is the next step in the preparation of Ordnance personnel. It is obvious, of course, that the training of all corps of the Army must be directed toward the same objective. In order to attain this end, the policy governing the training of all corps is laid down by the General Staff. The execution of training in the case of the Royal Canadian Ordnance Corps is supervised by the General Staff working in close coöperation with the Master General of the Ordnance Branch.

After basic military training, specialist training is carried out at Army trade schools and advanced Royal Canadian Ordnance Corps training centers. As an instance of the close coöperation between the United States and Canada, the facilities of the United States Army are made available for training Canadian personnel in tank maintenance.

As the concluding factor, and since it bears directly upon ordnance, a few comparative figures concerning Canadian industrial effort might be of interest. In terms of industrial output during the first World War, the value of munitions and other war material exported during that period equaled $1,002,672,000, whereas, in the present war, production of war materials in the year 1941 totaled $1,200,000,000; in 1942, $2,600,000,000, and is currently moving at an annual rate of $3,700,000,000.

Among the products of Canada's munitions factories are the 25-pounder gun-howitzer, the Bofors 40-mm. antiaircraft gun, the 3.7-inch antiaircraft gun, the 2-pounder and 6-pounder antitank guns, tank guns, and naval guns. Production also includes a wide variety of small arms, specialized technical equipment, small-arms ammunition, armored fighting vehicles, and motor transport. Production includes vehicles of over one hundred types—mobile workshops, wireless lorries, troop and ammunition transports, artillery tractors and trailers. A large part of the transport used by the Eighth Army in North Africa was produced in Canada.

Prior to this war, Canadian arsenals manufactured only one type of service small-arms ammunition. Today, some 22 types of 9 calibers are being produced by 60 times the number of employees who were so engaged in 1939. Four hundred and fifty thousand automotive vehicles have been produced in this war. The aircraft industry alone employs 93,000 workers. Another factory in Canada is the largest small-arms plant in the British Empire, employing 16,000 persons. In her production of war materials, Canada employs over 1,000,000 people, as contrasted with her total population of less than 12,000,000.

Figures and facts as shown here, however, do not fully indicate that Canada is producing practically every known article of war and that she is the fourth largest producer of war supplies among the United Nations—supplies which are being used on every battle front. The burden undertaken by Canadian industry has been a heavy one. The impact came suddenly with little real warning which might have allowed the first shock of adjustment to be absorbed by a step-by-step change-over from peacetime production. The work has not been simple, but the transition has been splendidly carried out under the Department of Munitions and Supply.

The word "transition" applies with full effect to the position of Canada during the past 3½ years. In that time, the Canadian Army has expanded over a hundredfold, and with it have grown the demands of the armed forces. In keeping with this expansion, the Branch of the Master General of the Ordnance and the Royal Canadian Ordnance Corps have also increased. All ranks of the Branch and the Corps are imbued with a determination to play their full part both at home and abroad in whatever rôle may be undertaken by the Canadian Army.

Aircraft Armor

An Analysis of the Defenses Required for Protection in Combat

Horace J. Alter

THE airplanes of the United Nations, thus far, have shown one distinctive advantage over those of the Axis trio in that adequate protective coverings in the form of armor plate, bullet-resistant glass, and leakproof fuel tanks have been provided. The ability of American aircraft to absorb punishment and gunfire has been demonstrated in the "box-score" losses of the opposing air forces: five Axis warplanes to one allied fighter; seven Jap Zeros to one Flying Fortress, and similar scores show a definite superiority of United Nations air equipment, not all of which can be attributed to superior personnel and tactics.

While performance with regard to speed, climb, and maneuverability of our aircraft may at times be adversely affected by the installation of armor, the benefits derived from such installation more than balance the drawbacks. Reports of the Army, Navy, and British Air Forces have shown that American airplanes have been able to return to their bases time and again with bullet-pierced structures and splattered armor plates. When the need for pilots with combat experience is so critical, the price, in weight, paid for their protection is very small. When the need for fighting aircraft is so vital, the price paid to keep them in action cannot be quoted in terms of speed and maneuverability.

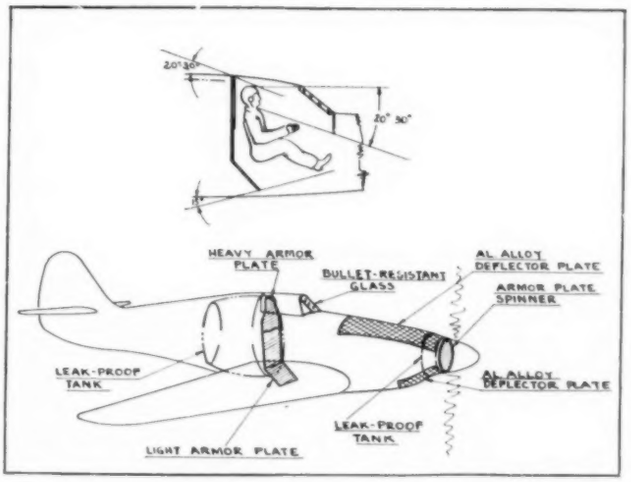


FIG. 1. PROTECTIVE ARMORING OF A SINGLE-PLACE FIGHTER

If a commander has to replace his squadron with equipment and personnel every three weeks, the effect upon morale and organization is very detrimental. Not only does he have to secure replacements, but he must also start over again a period of training and coördination so that the squadron will fight as a unit. Squadron tactics may be considered one of the essential differences between aërial combat in World War I and World War II. Squadron replacements must be kept to a minimum for both men and equipment to secure a smooth-operating fighting team and to keep the supply well within the demands. As Kipling so aptly put it, "It's not the individual, nor the army as a whole, but the ever-lastin' teamwork of every bloomin' soul."

As the protective padding of the football player gives him the assurance to tackle or withstand the shock of his opponent, so does the protective armor of his airplane give the pilot assurance to withstand enemy action until he has driven home his own attack.

Before considering how the pilot is to be protected, an analysis is presented to determine the relative vulnerability of one airplane to gunfire from another. It is demonstrated that the vulnerability depends upon (1) the types of gun installations in the opposing airplanes—whether the guns are fixed or flexibly mounted—and (2) the manner of attack—the relative approach angle between the two airplanes.

Bombers are more vulnerable to gunfire from multiplace fighters than they are to gunfire from single-place pursuits. Single-place pursuits are more vulnerable to gunfire from bombers and multiplace fighters than they are to gunfire from other single-place pursuits. Similarly, attack airplanes, patrol airplanes, and the like are less vulnerable to pursuit than to other multiplace fighting aircraft.

The opposing types mentioned above may be classified into three groups:

1. An airplane equipped with flexible guns versus an airplane equipped with fixed guns (bomber or multiplace fighter versus single-place pursuit);

2. An airplane equipped with flexible guns versus an airplane equipped with flexible guns (bomber or multiplace fighter versus a similar airplane);

3. An airplane equipped with fixed guns versus an airplane equipped with fixed guns (single-place pursuit versus a similar airplane). This class may be subjected to the same type of analysis as will be applied to the first class. It therefore will not be considered as a separate case.

Certain factors were neglected in making the accompanying diagrams in order to simplify the work. The effect upon the final results is of small consequence. Thus, the acceleration due to gravitational force is neglected in drawing the flight paths. Its effect upon the final shape of the curves would be to either slightly increase or decrease the total resultant acceleration over that shown. The shape and type of curve would remain the same.

The pilot of a pursuit airplane can perform certain aërobatic maneuvers such as wing overs, spins, or loops to bring his airplane into an advantageous attack position. Such maneuver is not plotted. However, the conclusions to be drawn from the following analysis are still applicable, since any attempt by the pursuing airplane to hold the attacked airplane in the gun sights will cause the flight path to approach and follow one of those shown in Fig. 2. The pursuing airplane is then subjected to the same restrictions as one which had followed the path throughout.

The following analysis is applied to airplanes which fall within Class 1—in this specific example a bomber with flexi-

Mr. Alter is a consulting aëronautical engineer. This article, with the permission of ARMY ORDNANCE, was presented by the author as a paper at the airplane design session of the Eleventh Annual Meeting of the Institute of the Aëronautical Sciences, New York City.

ble guns opposing a single-place pursuit with fixed guns. It is assumed that the speed of the bomber is 310 miles an hour and that of the pursuit 400 miles an hour, a speed ratio of $Vp/Vb=1.29$. Additional curves for a speed ratio of 1.03 are shown for comparison. It is also assumed that combat is started at 750 yards. This is very near the maximum range for a caliber .50 machine gun at which accurate firing and penetration of the projectile through light armor plate may be expected. The drop in bullet trajectory at this range does not increase the total dispersion beyond acceptable limits.

Fig. 2 is a graphical analysis showing the curves or paths of approach of a fixed-gun pursuit when attacking a bomber. The diagram is drawn in a flat plane but it should be envisioned as a spherical figure instead of a two-dimensional surface. The respective speeds of the airplanes are considered constant throughout the combat. Points O_b and O_p are the origins of the bomber and pursuit respectively. That is, the bomber is at point O_b when the pursuit is at point O_p. Corresponding positions in space for the two aircraft are indicated at 1-second intervals. Around the origin O_b are drawn 250-, 500-, and 750-yard range lines. The horizontal line through the bomber origin represents the flight path of the bomber which is assumed to fly in a straight line. Avoiding action may be taken by the bomber, but the mean flight path will be approximately that shown. The curved paths starting from 30, 60, 90, and 150 degrees represent the paths of approach and attack which it is necessary for the pursuit to follow to keep the fixed guns pointed at the bomber when the attack is started from any of these sectors. A series of interesting facts may be noted from these curves.

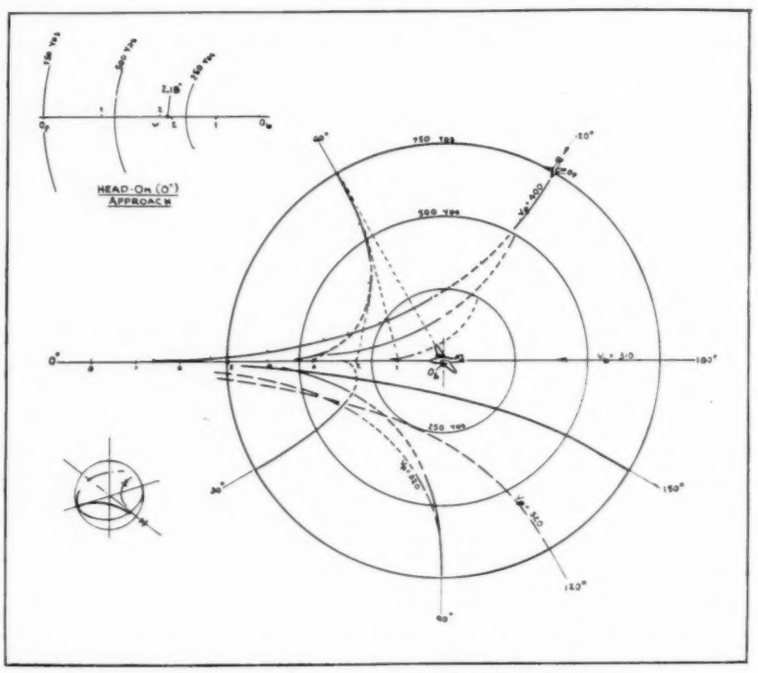


Fig. 2. Paths of Approach of a Fixed-Gun Pursuit when Attacking a Bomber

When a pursuit approaches the bomber head-on from 750 yards at zero degrees, the actual combat time is a matter of split seconds. In 2.18 seconds, the airplanes will meet in collision. An absolutely normal person will have a reaction time of not less than one-tenth of a second and not more than two-tenths of a second under favorable circumstances. This indicates that the pilot will probably have less than 2 seconds in which to line up the gun sights, fire the guns, and maneuver the airplane out of the path of the oncoming bomber. It is obvious that the effectiveness and accuracy of fire will be hampered by the short combat time. Furthermore, the target area is at a minimum in this type of attack. The period of sustained gunfire is very short, and combat will very likely be broken off after the airplanes have passed. There will be approximately twenty-six rounds fired from each caliber .50 gun for a 2-second burst.

There are certain advantages, to the pursuit, which occur in this type of attack: (1) The velocity and therefore the total energy of the projectile is increased, thereby increasing the bullet penetration; (2) The effective range of the bullet is increased due to the relative velocities of the two airplanes being added to that of the bullet; (3) The airplanes close range at a high rate of speed, thus reducing the time of flight of the bullet before it strikes the target. The trajectory of the bullet is flatter since the time during which gravity acts on the bullet is correspondingly reduced; (4) The dispersion of the projectiles is decreased due to the reduction in time of flight and distance traveled.

As the angle of approach increases from 10 to 110 degrees, the combat time increases, although not equally for both airplanes. In order to keep the guns trained on the bomber throughout the combat, the pursuit must have a rate of turn which produces accelerations in excess of 4g. The dotted portions of the curves shown in Fig. 2 indicate that part of the maneuver during which the radius of turn is less than 2,660 feet (the radius of turn for 400 miles an hour and 4g acceleration). The sharp radius of turn indicated for the 30-degree approach angle will produce an acceleration of approximately 39.4g while that for the 60-degree approach is approximately 12.2g. It is needless to state that the human body cannot withstand such accelerations.

It is evident that combat started from the 10- to 110-degree approach angles will be discontinuous in the case of the pursuit. Throughout such portions of the paths, in which the accelerations exceed 4g, the pilot will be temporarily blinded and may even lose control of the airplane for periods of 1.50 to 2.30 seconds. The gunfire is interrupted and is likely to be ineffective and inaccurate during these periods. The interrupted regions occur at close range to the bomber where normally the gunfire would be most effective. As an axiom to this, it may be stated that in an approach from angles of 10 to 110 degrees, firing must be started at long range in the first 1½ to 2 seconds of contact in order to be effective.

The relative speed between the airplanes when the pursuit approaches from 60 degrees is 905 feet a second. The deflection or lead which must be given to the bullet, due to the speeds of the aircraft, is 410 feet. The spacing between bullets, if the guns are firing at the rate of 800 rounds a minute, will be 166 feet. When the vulnerable length of the bomber is sixty-eight feet, it suffices that only two projectiles from any one gun will strike the target for any given sighting of the guns. The bomber, on the other hand may keep the

pursuit in the gun sights and field of fire throughout the entire period of combat. The pursuit may be followed with the flexible guns with increasing accuracy as the range decreases and without cessation of gunfire.

The accelerations will decrease below 4*g* as the paths approach tangency and the pursuit nears the bomber. This again indicates that fight before "the finish" only seems possible through simple pursuing tactics. It can be realized from the above analysis that the bomber is vulnerable only to a limited degree when attacked by a fixed-gun fighter or pursuit from angles of 10 to 110 degrees. The pursuit nevertheless is subjected to fire from the bomber's flexible guns at all times during the combat and with increasing effectiveness and accuracy as the maneuver nears completion.

As the angles of approach for the pursuit increase from 120 to 180 degrees, the period during which accelerations in excess of 4*g* will be experienced decreases since the paths of approach curve slowly. Also, the time during which combat takes place increases to a maximum and the interrupted portions fade out. Since the paths of approach are flatter, the pursuit may move off the path for a better position without producing excessive accelerations. It therefore retains some maneuverability which introduces the factor of surprise into the combat.

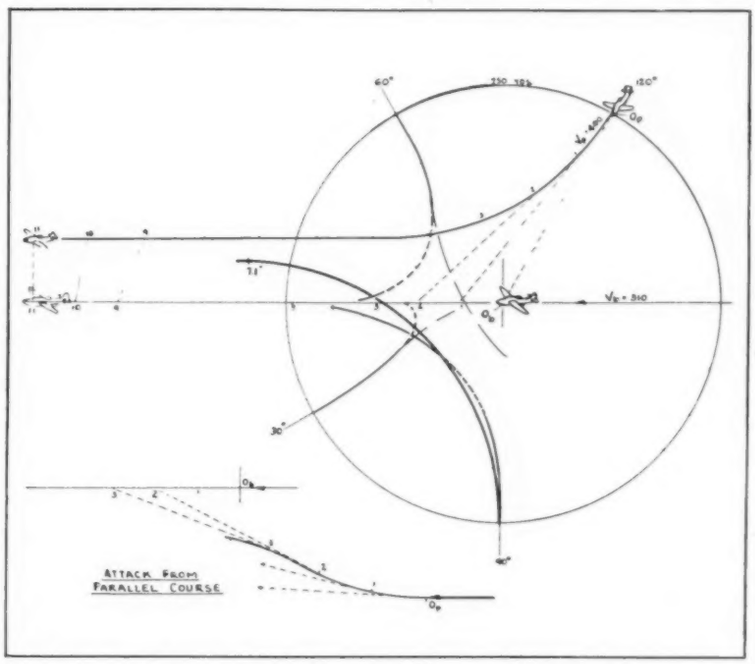


FIG. 3. APPROACH ANGLES OF A FLEXIBLE-GUN AIRPLANE WHEN ATTACKING A SIMILAR CRAFT

The effectiveness and accuracy of the pursuit's gunfire increase since the rate of change in angle is decreasing and the path is more nearly assymtotic. Slight errors in aiming and changes in airplane angle do not cause the line of fire to deviate by a wide margin as is the case for angles between 60 and 120 degrees. The pursuer therefore benefits by several advantages in attacking from the rear in that: (1) He experiences less physiological strain; (2) The duration of the combat is increased; (3) He still retains some maneuverability; (4) The probability of hits increases since slight errors in aiming do not cause wide deviations from the target; (5) The relative speeds between airplanes is decreased, enabling the pursuer to keep the target in the sights for longer periods.

It can be concluded from the above analysis that the bomber will be subjected to a greater number of attacks and longer periods of sustained gunfire from astern than from any other sector. All attacks by fixed-gun pursuits, regardless of the initial approach angle, tend to converge toward the rear and evolve into a simple pursuing action within a 45- to 57-degree cone.

Air battles formerly were fought at close range. With the ever-increasing speeds of combat, the advantages of being able to fire at long range become apparent. Range lines have been drawn in Fig. 2 at 250 and 500 yards to show that if a pursuer opens combat at close range, he must turn within a short radius, thereby causing accelerations which exceed 4*g* and materially reduce the chances of effective fire at close range. It may be safely stated that future combats of pursuit airplanes will be in straight paths and combat will open from greater distances.

THE analysis of opposing airplanes which fall within the second class—an airplane with flexible guns versus an airplane with flexible guns—is shown in Fig. 3. It is again assumed that the speed ratio is 1.29, the speeds are constant, and the range 750 yards.

Approach angles from zero to ninety degrees show very little advantage for the flexible-gun fighter over the fixed-gun fighter. It is subjected to the same paths and turn radii as the fixed-gun airplane. Nevertheless, since the pilot does not have to do the firing as in the case of the fixed-gun airplane, better accuracy and more effective gunfire may be expected than for Class 1 airplanes. The advantages of the multiplace flexible-gun fighter become apparent when the angles of approach increase above ninety degrees. The pilot may either take the same course as the single-place pursuit and bring the airplane into a tail attack or he may swing on a wider radius and bring it into a lateral attack. The path starting from ninety degrees, as shown in Fig. 3, is plotted for a radius producing an acceleration of 4*g* and shows that this acceleration would last for a period of 7.1 seconds. Since it is physiologically impossible to withstand an acceleration of this magnitude for six seconds without "blacking out," the pilot would be forced to reduce the radius of turn or break off the combat. He may also turn away from the attacked airplane and still maintain combat for a limited time as shown by the extended paths of the 30- and 60-degree approaches.

The pilot has more latitude as the approach angles increase and can maneuver the airplane into any position producing the best target for his gunner's fire. In an attack from 120 degrees, he may bring his airplane alongside his opponent in 11 seconds. The resulting lateral attack, whether it be from above, below, or alongside, will produce the largest target area. The multiplace flexible-gun fighter may even fly ahead of the attacked airplane and fire to the rear, an action which is very advantageous to the leading airplane. It is thus seen that the flexible-gun fighter has a distinct advantage in that it can pick out any defenseless and vulnerable areas and can concentrate its gunfire on those

areas. There is no portion of the attacked airplane that is immune to the flexible-gun fighter.

A special case is shown in Fig. 3 wherein the pursuing airplane sights an opponent while both are flying a parallel course. Assuming the pursuer makes a turn which will produce an acceleration of 4*g*, it is seen that for the first 2 seconds of combat the pursuer, if it is a fixed-gun fighter, cannot fire a single shot that will be aimed at the attacked airplane. In the meantime, it is being subjected to gunfire itself if the opponent is a flexible-gun fighter. The fighter with flexible guns does not have to be pointed at the opponent, and therefore combat can be opened immediately on sighting the target.

These analyses show that for the fixed-gun pursuit, attacks originating from seventy-five per cent of the sphere will develop into a pursuing action to the rear of the attacked airplane. Attacks from the remaining twenty-five per cent of the sphere will be frontal and lateral attacks which will probably be discontinuous or broken off after a few seconds. Attacks for the multiplace flexible-gun or turreted fighter, originating from any portion of the sphere outside the forward twenty-five per cent, may develop into a pursuing, leading, or lateral attack. It should be noticed that in the majority of cases the initial entry will be made in a pursuing action with the gunfire concentrated at the rear of the attacked airplane.

AIRPLANES are also vulnerable to gunfire from ground antiaircraft batteries and to bombing attacks from other aircraft. Such attacks must be avoided by taking advantage of speed, rate of climb, and maneuverability. These would be penalized by an excessive and unwarranted weight increase were protection against a direct hit from the above sources provided.

Protective armoring may be divided into three classes: (1) Ferrous plate which is usually face-hardened or homogeneous steel armor plate; (2) Nonferrous plate such as aluminum alloys, beryllium, bullet-resistant glass, plywood, plastic, and other composite materials; (3) Auxiliary equipment and structure such as leakproof tanks, tires, wheels, radio equipment, instruments, wing structure, and similar items.

Steel plate is used to protect areas which are likely to be subjected to direct gunfire or to protect personnel. This type of plate is superior to others when the angle at which the bullet strikes the plate is nearly normal. Light steel plate may be used in some cases by installing the plate at angles so that it receives a glancing impact instead of a normal blow. Aluminum-alloy plates are superior to steel plates when the angles of obliquity are greater than forty-five degrees. (The angle of obliquity is defined as the angle between a line normal to the plate and a line through the flight path of the bullet.) It is used for deflector plates and protective covering where the line of impact departs considerably from the normal to the plate. It is lighter than steel for equivalent ballistic properties when used at angles greater than forty-five degrees. When used as a covering for the airplane skin, it can cause complete deflection or tumble the bullet sufficiently to stop penetration of armor plate.

Composite plates, plywood, plastics, and the like are all used as deflector and baffle plates. In some cases where flowering of metallic structure is likely to cause secondary damage or prevent bullet holes from closing, as in leakproof tanks, the use of plywood instead of metal as a baffle is recommended. Auxiliary equipment and structure serve as deflector and tumbling plates and are an effective means of decreasing bullet penetration.

THE areas which are likely to be subjected to the heaviest gunfire and the location in which protection should be provided for crew members, equipment, and vital parts of the airplane can be determined from the graphical analyses presented in Figs. 2 and 3.

The areas at the tail of the airplane are subjected to a greater percentage of attacks and longer periods of gunfire than areas at the front and sides. The preponderance of armor plate and deflecting shields should provide protection against gunfire from within a 45- to 67-degree cone to the rear of the airplane. Heavy armor plate should be used up to thirty degrees on either side of the longitudinal axis, since all attacks tend to concentrate at the rear and most sustained gunfire will be directed at the tail. Head-on attacks are extremely limited with regard to area attacked and period of sustained gunfire. However, attacks by multiplace fighters using a leading action—flying in front of the attacked airplane and shooting back—can occur frequently. It is therefore necessary to provide heavy plate at the front to protect against gunfire from within a 30-degree cone forward of the airplane. The plate must be heavy enough to compensate for the increased velocity of the projectile due to the relative speeds of the airplanes being added to that of the bullet.

Protection also must be provided at the side since this area is subjected to oblique gunfire from fixed- and flexible-gun fighters during the initial phase of the attacks. In the case of an attack by flexible-gun fighters, the side areas may be subjected to sustained fire. Light-gauge armor plate may be used for protection against direct gunfire, and aluminum-alloy plates may be substituted for light skins as deflector plates and shields. Light-gauge plate is usable since the majority of gunfire will be at long range and oblique angles.

PRIMARY consideration should be given to the crew members when determining the location of armor plate. Personnel located in the nose should be protected against direct fire by heavy plate with lighter wings or side shields to protect against lateral fire. By putting the plate close to the individual to be protected, the area of plate can be reduced to approximately eight square feet for full protection. Careful placement of equipment such as the nose wheel, instruments, and auxiliary equipment will also serve to protect any member of the crew located forward.

The installation of heavy armor plate at the rear of the spinner on the single-place pursuit serves as protection for the engine and pilot at the same time. Bullet-resistant glass in the windshield will protect the face and chest of the pilot. The installation of leakproof fuel and oil tanks in front of or behind the pilot also provides additional protection. The single-seat pursuit is protected against fire from the rear in the same manner as flight crew members are protected on multiplace fighters, with the exception that single-place pursuits must also provide armor protection for the pilot's seat and legs since there is rarely enough protection provided by adjacent equipment as is the case for the larger airplane. Fig. 1 shows the position of armor to protect a single-place fighter.

Personnel in the flight station (pilot, copilot) and those in compartments adjacent to the flight station require protection against forward gunfire and fire from the rear. Fig.

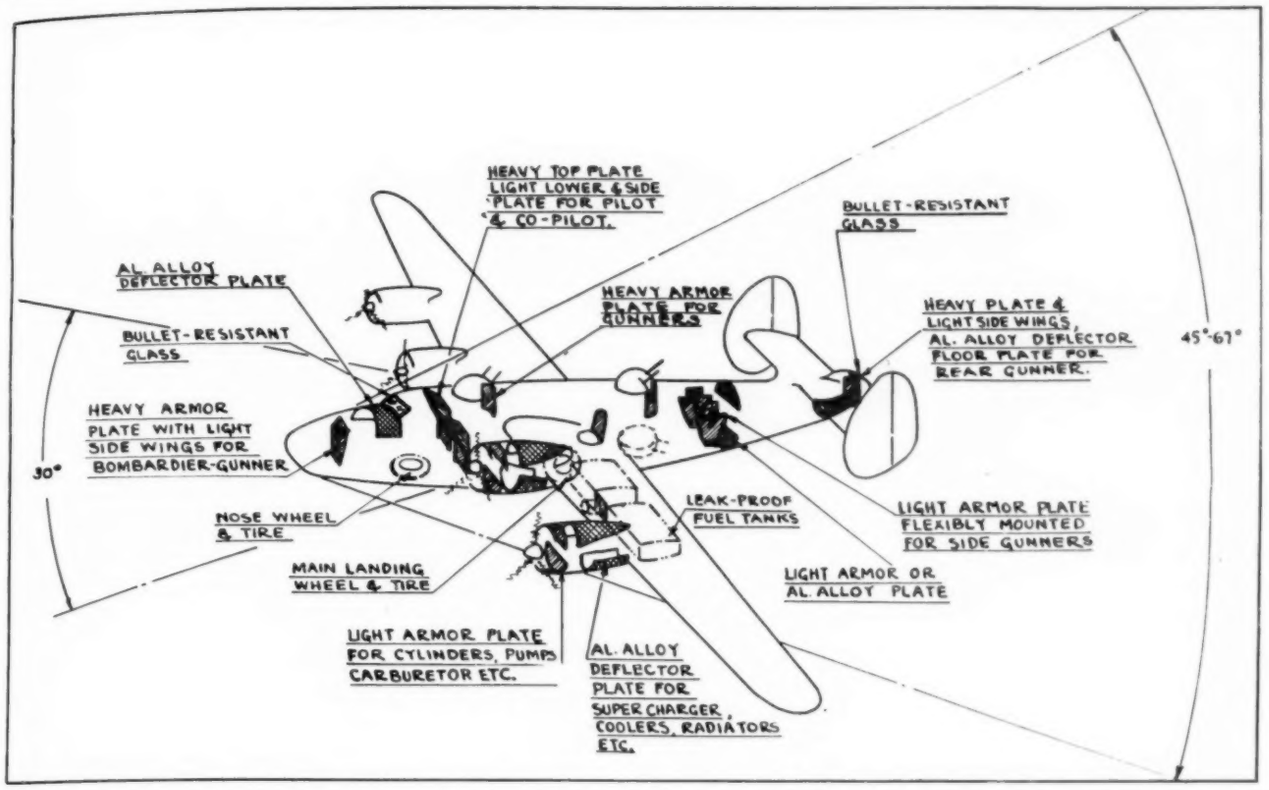

HEAVY TOP PLATE LIGHT LOWER & SIDE PLATE FOR PILOT & CO-PILOT.
BULLET-RESISTANT GLASS
AL. ALLOY DEFLECTOR PLATE
HEAVY ARMOR PLATE FOR GUNNERS
HEAVY PLATE & LIGHT SIDE WINGS, AL. ALLOY DEFLECTOR FLOOR PLATE FOR REAR GUNNER.
45°-67°
BULLET-RESISTANT GLASS
HEAVY ARMOR PLATE WITH LIGHT SIDE WINGS FOR BOMBARDIER-GUNNER
30°
LEAK-PROOF FUEL TANKS
LIGHT ARMOR PLATE FLEXIBLY MOUNTED FOR SIDE GUNNERS
NOSE WHEEL & TIRE
MAIN LANDING WHEEL & TIRE
LIGHT ARMOR OR AL. ALLOY PLATE
LIGHT ARMOR PLATE FOR CYLINDERS, PUMPS CARBURETOR ETC.
AL. ALLOY DEFLECTOR PLATE FOR SUPER CHARGER, COOLERS, RADIATORS ETC.

FIG. 4. THE LOCATION OF ARMOR-PLATE PROTECTION ON A MULTIPLACE AIRPLANE

4 shows the location of armor-plate protection on a multiplace airplane. Bullet-resistant glass and aluminum alloy plates may be used to protect the face and upper parts of the body against forward gunfire.

Protection against gunfire from the upper sector of the rear cone should be heavy armor plate. The plate should cover the head and shoulders so that protection is provided against any gunfire from within the cone defined by a line drawn from the direction of the attacking gunfire over the edge of the armor plate and tangent to the body of the crew member to be protected. The upper plate may be welded to a lower plate of lighter gauge which protects the body from the region of the lungs down to the bottom of the seat. Light plate may be used for the lower part since any bullets striking in this area are likely to have passed through other portions of the structure and lost some of their energy and penetrative power.

Protection against gunfire from the lower sector of the cone may be provided by equipment, fuel tanks, wheels, tires, and structure. Heavy aluminum-alloy sheets may be used for skin, at the same time serving as deflector plates for both crew members and vital equipment. The flight station, being adjacent to the engine nacelles, is usually protected against side fire by the wing and engine groups. However, in the single-place pursuit with one engine, side protection must be provided. It is usually sufficient to extend the back plate or place equipment at the sides.

Protection of crew members in the aft portion of the airplane against lateral fire is most valuable in the form of flexibly mounted plates. Side and waist gunners, who are usually the ones to be protected, are likely to need protection in the direction in which they are firing. Flexibly mounted plates need less area to protect than fixed plates because the gunners are moving about and thus would require greater coverage if fixed plates were used. Again, good judgment in placing the armor plates will enable them to be used for protecting guns, ammunition, and equipment as well as personnel.

AIR action and losses indicate that power-plant installations constitute one of the chief remaining areas vulnerable to fighter attack. Damage to engine accessories such as carburetor, generator, fuel pump, magneto, and supercharger may cause immediate stoppage, while damage to radiators, oil coolers, fuel lines, hydraulic lines, and electric wiring constitutes a secondary source which may cause engine stoppage after a short time or cause serious difficulty. Protection must be provided for the engines of bombers and multiplace fighters against gunfire from within the 14- to 32-degree cone to the rear by the installation of light armor plate.

It has already been demonstrated in actual combat that considerable protection is given to the vulnerable portions of the engine group by such installations as the landing gear, self-sealing fuel and oil tanks, airplane structure, and air ducts. Vulnerable power-plant components should be positioned so that they are protected by existing aircraft structure and equipment.

Vital equipment, such as oxygen bottles, hydraulic accumulators, auxiliary power plants, ammunition containers for cannon shells, and similar matériel must either be protected by plate or placed in areas which are less vulnerable to gunfire. Areas which are subjected to frontal or lateral attack are suitable locations for such equipment. By concentrating vital mechanisms and personnel in specific areas, they may be protected with fewer pieces of plate. Careful consideration of armor plating in the initial stages of design will save weight and provide less vulnerability for the airplane and its crew.

Enemy Weapons

The Collection and Analysis of Captured Matériel

Col. Scott B. Ritchie

TODAY on all battle fronts American ordnance is being tested in deadly combat against the greatest array of enemies to oppose us in all history. They are armed with weapons which are the products of years of planning and building and the best that their mobilized scientific talent could devise. Nor are they standing still, for they realize they are now in desperate competition wherein, other things being equal, the nation which leads in design and production of the most deadly weapons will surely win.

Our enemies are shrewd and able. We may be certain they are doing everything in their power to develop new weapons, to spring surprises, and to improve the effectiveness of their existing equipment. This competition is as real and significant as that on the battlefield, for on the performance and dependability of weapons rest the lives of soldiers and the outcome of the conflict. On our part, this competition is intimately extended from the Office of the Chief of Ordnance in Washington to every theater, to every battle front. It is absolutely vital for us to maintain our lead in the fighting tools the Ordnance Department is providing for our armed forces. It is the purpose of this article to show how we obtain and utilize detailed engineering information on enemy ordnance which helps us to maintain our superiority and to make our war effort more effective.

ONE of the most vital tasks the Ordnance Department has at this stage of the war is to make sure that our armament is better than that of our enemies. There is no doubt now that our fighting equipment, all told, is superior to any that the enemy has—individually and collectively. The American people need have no worry about that.

But Ordnance will fail in its duty if the American fighting forces do not always lead the parade of superior weapons. To make sure that the Industry-Ordnance team does not fail in this responsibility, the activities described in the accompanying article by Colonel Ritchie are conducted with the utmost precision, industry, and speed. We are constantly assembling captured enemy equipment from the battlefields of the world. Our Ordnance engineers and scientists are studying it at the Aberdeen Proving Ground, and whenever we come across a good idea—which infrequently happens—we make use of it. This study of captured enemy equipment is just another instance of the way the enemy can be defeated—with the good features of his own weapons if need be.—MAJ. GEN. L. H. CAMPBELL, JR., Chief of Ordnance, U. S. Army.

The necessity for systematic organization to accomplish this mission was early realized. The framework for this consists of (1) a small unit in the Service Branch, Technical Division, Office of the Chief of Ordnance, to supervise and coördinate the project as a whole; (2) an organization at Aberdeen Proving Center to receive, catalogue, and examine the foreign matériel returned for that purpose; (3) field agencies to collect and ship the matériel from the battlefields to Aberdeen; and (4) various governmental, commercial, and private research organizations to make engineering tests and analyses. It may be well to examine the organization more in detail to appreciate the work being done.

The coördinating unit in the Office of the Chief of Ordnance, known as the Ordnance Intelligence Unit, Development Analysis Section, Service Branch, Technical Division, is staffed with officer and civilian personnel especially selected because of their knowledge of ordnance, both foreign and domestic. This unit performs the following functions: (1) It maintains liaison with other branches of the Army, and with the Navy and Marine Corps, to facilitate the gathering, dissemination, and exchange of foreign ordnance information. (2) It maintains liaison with Aberdeen Proving Center, Ordnance arsenals, the Tank-Automotive Center in Detroit, United States ports of entry for foreign ordnance matériel, service schools, outside agencies coöperating on examinations of foreign ordnance, and other accredited agencies. (3) It coördinates efforts among the Foreign Matériel Branch of the Proving Center, Aberdeen Proving Ground, the Office of the Chief of Ordnance, and other interested agencies. (4) It analyzes military and naval attaché reports and other reports and cables of interest to the Ordnance Department and directs information secured from such sources to the proper offices of the Department. (5) It collects all available data on specific foreign ordnance from libraries and other sources. (6) It prepares and distributes thrice-weekly intelligence summaries, (7) provides technical data to the Field Service Division, Office of the Chief of Ordnance, for preparation of operation and maintenance manuals on enemy ordnance matériel, and (8) prepares technical articles on foreign ordnance as authorized for War Department publications.

THE Ordnance Intelligence Unit also maintains a record of all items received from abroad, coördinates the test program for examination and analysis of each item to be processed, and disseminates reports and other information to those who should receive this material. It maintains a close liaison with such agencies as the Office of Strategic Services and the Board of Economic Warfare. To each of these agencies go copies of the reports that are prepared on examinations of foreign weapons.

Realizing the magnitude of the problem, a foreign matériel branch was early established in the Proving Center at Aberdeen to receive, photograph, catalog, and make available for most effective examination the matériel obtained.

Colonel Ritchie is chief of the Service Branch, Ordnance Department Technical Division.

FIG. 1. CAPTURED WEAPONS IN THE FOREIGN MATÉRIEL BRANCH DISPLAY AT ABERDEEN PROVING GROUND

Promptly upon receipt of any item it is reported to the Ordnance Intelligence Unit with a suggested program for test or study. This program is coördinated with the development branches of the Technical Division and others in the Office of the Chief of Ordnance to insure that all essential data on the item are obtained in a systematic manner, that there is no undue duplication of effort, and that all desirable examinations are carried out promptly. After coördination, the programs are released and directives issued for the tests.

These cover among other things road tests for automotive equipment; firing tests for guns and ammunition to determine ranges, muzzle velocities, penetration of armor, and similar data; detailed analyses and tests of fuels and lubricants, propellants and high explosives; and examinations of metal components to determine strength, composition, and processes of manufacture. Design studies enter all phases of these investigations.

Some of this work may involve only such examinations as can be carried out completely at Aberdeen. However, this is seldom the case. Agencies outside the Proving Center are enlisted to perform appropriate parts of the investigations. For example, the arsenal laboratories are tapped for their share of the work; notably, Watertown for ferrous metallurgy, Frankford for nonferrous metallurgy and fire-control instruments, Picatinny for propellants and explosives, and Rock Island for fuels and lubricants. Contracts have been made with industrial concerns to carry out certain projects where Government facilities are inadequate or overcrowded with other work. Close liaison is maintained with the National Defense Research Committee in the examination and exchange of information on foreign matériel. Division 18 of the N.D.R.C. (through the War Metallurgy Committee of the National Research Council) is actively assisting in the examination of such foreign ordnance as may be desirable, with special emphasis on the strategic aspect, to uncover hidden processes of manufacture which may be helpful to our industry, to disclose changes and defects in manufacturing procedures, bottlenecks, and shortages in enemy industry. These examinations are of special interest to the Office of Strategic Services and to the Board of Economic Warfare. In these examinations, as well as on other projects which the N.D.R.C. is carrying forward for the Ordnance Department, a service of great value is being rendered in the war effort.

To obtain the information necessary on foreign ordnance, maximum utilization was made and is still being made of well-established channels for that purpose. Close coöperation is maintained with the Military Intelligence Service (G-2), and hundreds of G-2 and other reports are analyzed each month for significant information on enemy ordnance. These, however, could not be expected to meet the needs for complete technical data; moreover, enemy matériel was needed for design studies and training purposes. Therefore approval was obtained from the War Department General Staff to send special Ordnance observers (officers and enlisted men) to all active theaters of operations with the sole mission of making engineering analyses of enemy ordnance, to photograph where desirable and prepare descriptions on the spot, and to ship desired matériel to Aberdeen for further analysis. The need to obtain certain information in the field so that it could be returned by mail is indicated by the fact that several valuable cargoes have been lost at sea.

THE officers and enlisted men, especially selected for this unique and highly important mission, were all given a thorough course of training at Aberdeen Proving Ground. They were also given intense instruction by the Office of the Assistant Chief of Staff, G-2, in Washington, and indoctrination by the development branches of the Technical Division in the latest trends in ordnance developments. This included instruction in the most significant points to be covered in enemy weapons. Thus trained and indoctrinated, these officers and men are equipped to be the eyes and ears of the Office of the Chief of Ordnance. Others are similarly trained and available for any important new theaters that may be opened. The wisdom of this planning is now bearing fruit in the ever-increasing quantities of material arriving at Aberdeen and in the reports from abroad which disclose data of great technical importance.

These Ordnance observers are attached to G-2 of the theater for administrative purpose, but their technical mission is performed under the direction of the Chief of Ordnance. It is to be noted that their work in no way displaces any of the intelligence activities of G-2, whose exceedingly valuable reports continue to come in to the Ordnance Intelligence Unit where they are analyzed and studied and the data provided made available for use in the development and improvement of our ordnance matériel.

Close liaison is maintained with the Ordnance observers by cable and personal contact by those visiting the various theaters from the Office of the Chief of Ordnance. Frequent regular reports are received as well as special cables where occasion dictates, so that full advantage is taken of any new developments on the enemy front. As Maj. Gen. G. M. Barnes, Chief of the Ordnance Technical Division, has stated,

the objective is to know *everything* and *why* about enemy equipment. For example, if the enemy changes the design of a firing pin in a fuze, we not only want to know what change has been made but also *when* and *why*.

THE matériel received at Aberdeen serves, among others, the following purposes: (1) Analysis of enemy designs for ideas with which to improve our own ordnance; (2) Determination of the basic trends of enemy ordnance design as a guide for our future design policies; (3) To uncover weaknesses in enemy equipment upon which we may capitalize both in design of our matériel and in combat; (4) To check for substitute (*ersatz*) substances as an indication of shortages in enemy raw materials, improvements in manufacture, and possible use in our own equipment; (5) For strategic analysis; (6) For use in preparation of operation-and-maintenance manuals for issue and training of our own troops so that they may know the enemy equipment and how to use it upon the enemy when the equipment is captured, if the occasion permits, or how to destroy it if desired. This is exceedingly important, and considerable enemy equipment has already been furnished to troop units and schools for training purposes.

To date, 336 German, 102 Italian, and 67 Japanese weapons and ammunition of different types have been received at Aberdeen. These cover a wide range of matériel. In so far as practicable, one of each item is held in the museum at Aberdeen where an extensive and ever-increasing collection is being accumulated. A view of the foreign-matériel exhibit at Aberdeen is shown in Fig. 1. It is to be noted, however, that not all the items which have been captured and are now on hand can be shown publicly or information concerning them disclosed. The reason for this is obvious, since disclosure of the fact that certain items of special significance are known to us or are physically available to us may be helpful to the enemy. Typical of the items which can be mentioned and which have been of interest are the following:

FIG. 2. GERMAN 7.92-MM. MACHINE GUN, MG 42

The German 88-mm. Gun.—This famous weapon has long been known to our Ordnance officers and has been completely proof fired and otherwise examined at Aberdeen. Originally designed for antiaircraft missions, it has been used extensively by the Germans in Africa as an antitank gun when supplied with armor-piercing ammunition. As is true of several of our weapons of comparable size and superior performance, it is effective against tanks, especially when used in ambush at relatively short ranges. Examination of the first model of the 88 shipped from Africa to Aberdeen revealed a damaged barrel. A new one was promptly ordered from the battlefield. Upon delivery, the new barrel was installed for extensive proof testing with captured ammunition and the damaged barrel cut up for metallurgical examination. An interesting, although not new, feature was the construction of the liner of the gun in three separate sections (Fig. 4).

FIG. 3. JAPANESE 6.5-MM. MACHINE GUN, TYPE 96

The Japanese Grenade Launcher ("Knee Mortar").—This dangerously misnamed weapon (to fire it from the knee invites a broken leg) possesses certain apparent advantages for jungle fighting. It projects a small bomblike grenade further than a Jap could throw a hand grenade. However, comparative tests with several of our own infantry weapons showed the "knee mortar" to have no features not present in our own weapons and to possess many inferior characteristics.

The German Volkswagen.—The German "People's Car," which the German people paid for but never used, was designed to perform the same rôle as the American jeep. Compared with the jeep, however, it is underpowered and weak in frame and could not attempt those operations for which the jeep has become famous (see photo on p. 110).

The German Half-Track.—The German half-track is more properly termed a three-quarter track. Its principal use is as a personnel carrier and prime mover, although it has also been employed as a mount for lighter types of artillery. It has a high silhouette, and to the American eye resembles in appearance one of the early automobiles of pre-World War I vintage (see photo on p. 111).

The German 28/20-mm. Tapered-Bore Gun (Gerlich Gun).—The Germans have developed and put on the battlefield several different sizes of guns using the tapered-bore principle. The "squeezed down," lightweight projectiles fired by this type of weapon have a high muzzle velocity but very poor external ballistic properties. Consequently, the bullet loses its higher initial velocity early in flight and the gun is not any more effective than the standard type at ranges greater than a few hundred yards.

The Japanese Nambu Light Machine Gun.—This old-type copy of the French Hotchkiss gas-operated machine gun is the standard light machine gun of the Japs. Its caliber is small, 6.5-mm. (.256-inch), and its hopper feed, while simplifying the ammunition problem (it uses six 5-round rifle clips at a time) makes for a very slow rate of fire. A newer type of light machine gun, Type 96 (Fig. 3), is a poor Jap copy of the Czech Brno (the father of the British Bren light machine gun). It uses a magazine feed and still clings to the 6.5-mm. caliber. It is not too effective for this reason.

The German 105-mm. Howitzer.—This weapon was one of the first pieces of German artillery to be thoroughly tested

at Aberdeen. It is in no way superior and in some important characteristics inferior to our standard 105-mm. howitzer (see photo on p. 106).

The German Machine Gun 42 (1942 Model Machine Gun).—The machine gun 42 is the successor to the machine gun 34, the standard German machine gun in the class of our

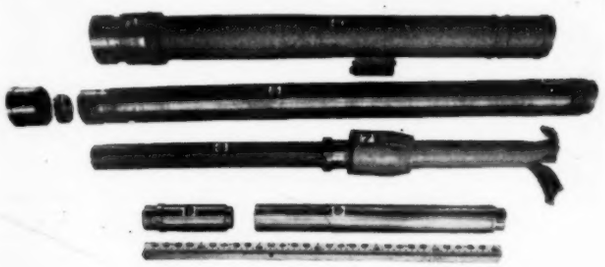


FIG. 4. TUBE AND LINERS OF GERMAN 88-MM. GUN

cal. .30. Unlike the 1934 model, ninety-eight per cent of the 42 model is made of stampings with a bare minimum of machining. It shows that the Germans have redesigned in a determined effort to cut down machine-tool hours and other manufacturing costs. It has a very clever method of rapid barrel change. This weapon is being very carefully studied from both the military and manufacturing viewpoints. (Fig. 2 shows the gun with cover open, barrel-release catch open, and barrel partly removed. Preponderance of stamped parts is clearly shown.)

The German Schmeisser Submachine Gun (M.P. 40).—This Axis version of the "tommy gun" fires 9-mm. (.354-inch) ammunition from a 32-round detachable box magazine. It is a straight-blow-back gun with a practical rate of fire of 80-90 rounds a minute. This rate of fire is considerably less than that of the Thompson submachine gun. The German 9-mm. bullet is substantially smaller and lighter than our caliber .45 bullet and correspondingly less effective against personnel.

The Italian Breda Machine Gun, Model 37.—This latest of standard Italian ground weapons fires an 8-mm. (.315-inch) projectile at a cyclic rate of 450 rounds a minute. It compares favorably with the standard ground machine guns of other countries. This weapon is better than the average Italian weapon, which is generally inferior to the comparable modern weapon used by either the Germans or the allies.

ANALYSES of enemy weapons have revealed interesting and significant trends in enemy ordnance. German weapons show evidence of typical Teutonic thoroughness and many years of planning for this war. It would be a serious mistake to underrate German ordnance design and manufacture because of a few weaknesses. Every day brings evidence that the Germans are constantly improving the design and manufacture of their weapons. An illustration of this is the increase in the amount of alloys in the armor used in the Pz. Kw. IV tank over that used in the Pz. Kw. III. Guns of increased firepower are appearing in tanks and on self-propelled mounts. It is *very significant,* however, that none of our investigations or reports from the front have revealed any "mystery weapon" or any weapon of firepower superior to standard American ordnance.

The Germans are using such *ersatz* materials as plastics for gunstocks and steel for cartridge cases. It is quite evident that they have a thorough conservation program and are being increasingly forced to save on those materials which are critical in their economy.

The machine gun 42, mentioned above, shows a German trend toward economy of manufacture and man power by redesign to reduce machining by extensive use of stampings. Other evidences of this may be expected in the near future. German welding, although quite extensively used, has been found to be inferior to American welding. The Germans are not above copying a good American idea for increasing firepower. This fact was evidenced by the recent appearance on the battlefield of a German semiautomatic rifle (Fig. 5) similar to our standard M1 rifle (Garand).

Italian weapons reveal the inadequacy of the Italian system. With a few exceptions (notably the Breda machine gun), Italian weapons are copies of World War I models or of more recent German and French designs. The Italians use much World War I matériel and other weapons obtained from the Germans, French, Austrians, and Czechs.

IN the design of fighting weapons, the Japanese have rightly been called "the amazing imitators." They have procured many weapons from various armament firms throughout the world and have copied others extensively. They have copied English Vickers and Lewis aircraft machine guns, French weapons, German artillery, American trucks, motorcycles and machine guns, Swedish Bofors, Swiss Oerlikon, and even Danish guns. Japanese ordnance tends to be lighter and of inferior firepower. This doubtlessly is designed to give the smaller Jap soldier less weight to carry in amphibious and jungle operations, where poor visibility and close-quarters combat somewhat neutralize the advantages of more powerful weapons. It is also obvious that Japanese industry cannot mass produce high-quality weapons over a long period of time to compete successfully with American weapons.

In conclusion, it can be definitely stated that neither Ger-

FIG. 5. GERMAN 7.92-MM. GEWEHR 41 SEMIAUTOMATIC RIFLE

many, Italy, nor Japan has demonstrated any weapons superior in military effectiveness to the best American standard. It seems entirely logical that, as the war progresses, the superiority of American ordnance will become more pronounced as the impact of American design and productive ability is brought to bear in greater measure on the enemy. This fact, coupled with the courage and ability of our fighting forces and those of our allies, is the surest guarantee of ultimate victory.

Classifying the Ordnance Soldier

His Assignment Is Now Based on Ability and Aptitude

Capt. Robert C. McQuiston

AS a modern army needs the best equipment in the proper places at the right time, so does it need men trained according to their individual abilities in the right place at the right time. The modern Army's demand for specialists, technicians, leaders, men of combat, men for the several thousands of duties requiring particular aptitudes, temperaments, and training is inexhaustible. It can ill afford to waste the individual capabilities of the men in the ranks and of the thousands pouring into its ranks from our highly specialized civilian economy. The fact is that the Army has become an industry of global proportions, a diversified and far-flung organization in which the labor component is a critical factor.

The human raw materials are available, for our industry is the most highly developed and specialized in the world. The problem is to allocate skills in such a way that with additional finishing (and in many cases conversion with a minimum of cost in time and facilities to something more vitally needed) the finest possible final product will be accomplished. To this end The Adjutant General's Department instituted the present personnel classification and assignment system.

Concern with personnel management as such is a comparatively recent development. Particularly is this so with respect to the Army. Prior to World War I, our Army had proceeded on the apprenticeship theory born of the days of individual artisanship and infant industry. That is to say, little or no attention was paid to the individual characteristics and abilities of the entering recruit in making assignments, and such training as was necessary was given on the job. As far as the Army was concerned, one man was very much like another. An army was supposed to learn to fight as a unit and that was practically all there was to it, or so it was considered.

The costly waste involved in initial failures in the assignment of men with special skills became increasingly apparent as the war progressed. Endless delays in training and disruptions of units already fully established and in the field caused by necessary transfers and reassignments were the penalties paid for the lack of a comprehensive classification and assignment system. One can only guess at the cost in human lives which resulted from the lack of the right men in the right places.

From this bitter experience, the makings of the present personnel classification and assignment system emerged. By the time World War I ended, a fairly comprehensive classification and assignment service, including the development and administration of the famous Army alpha intelligence tests and the maintenance of a very simple index of direly needed experts, was in operation. The service was instituted in every cantonment and in the replacement pools of the Expeditionary Force.

It was perhaps natural that, with the advent of peace and the drastic reduction of the Army, the system should be all but forgotten. Nevertheless, the foundation had been laid, the experience gained.

While personnel practice in the Army languished, the increasing complexity of industrial and social conditions in general and the rise of mass-production industries in particular gave great impetus, in the 'twenties, to the study and development of such subjects as personnel management, industrial psychology, vocational guidance, and employment practice. Thus, when the present emergency came upon us and we were confronted with a personnel problem of the greatest magnitude—the organization of a complex, mobile, mechanized Army—we had available an important body of knowledge and tested techniques, as well as the trained personnel. A number of the distinguished members of the new profession were gathered together in the Personnel Procedures Section of The Adjutant General's Department, and the present personnel classification and assignment system was the result.

General-policy formulation relative to Army personnel management is a function of the War Department General Staff (G-1). The Adjutant General participates in the preparation of policies and through the classification and replacement branch of his office controls their execution and administration. In all echelons below the War Department, personnel management is a function of command. The local adjutant general or adjutant is responsible to the local command for the administration and the technical details of personnel. The larger units have classification officers responsible to the local command, usually through the adjutant, for personnel classification and assignment.

The personnel classification and assignment system operates in its initial stages principally through the reception centers operated by The Adjutant General's Department and the replacement training centers operated by the Ground, Air, and Service Forces.

AT the reception center the entering soldier is given the Army general-classification test, the radio operator's aptitude test, and the mechanical-aptitude test. By means of the first, the Army measures the recruit's ability to learn as well as his ability to think quickly—both important attributes of the soldier. With the aid of the mechanical-aptitude test, the Army uncovers the potential mechanics, many of whom in civilian life may have been working in white-collar jobs. The clerk or salesman may have been perfectly suited to his civilian occupation but may also possess mechanical aptitudes which are more important to the Army than clerical or sales ability; or the man who enjoys working with machines may never have had an opportunity to do so as a means of earning a livelihood. The test does not seek to discover those men who have actually done mechanical work so much as it seeks to indicate a man's potential ability to learn and his probabilities of success in mechanical work.

The second step in the Reception Center classification process is the interview. It is at this junction that the basic

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classification record, the Soldier's Qualification Card (W.D., A.G.O. Form No. 20) is initiated (Fig. 1). A card with the soldier's name and serial number as well as his test results entered thereon (items 16 and 17, Fig. 1) is handed to the soldier as he is directed to the classification specialist who conducts the interview. At the interview, the recruit is questioned concerning his education, civilian occupation, knowledge of foreign languages, ability to furnish public entertainment, sports, hobbies, leadership experience, and previous military experience. These facts are recorded in a uniform manner on Form 20 according to Army Regulations (AR 615-25, July 13, 1942).

The most important phase of the interview is that pertaining to civilian occupations (items 13 and 14, Fig. 1). The interviewer secures the complete work history of the recruit and then records his main and second-best civilian occupation, considering such factors as length and recency of experience, the skill and responsibility involved, and its bearing on assignment of Army work. This classification must be accomplished according to uniform nomenclature for occupations as set forth in an Army index of occupational specialists (AR 615-26, September 15, 1942), or the Dictionary of Occupational Titles prepared by the United States Employment Service. The former contains those civilian occupations considered applicable to a specific Army assignment, as well as actual military occupations. The latter, on the other hand, comprises nearly all civilian occupations. If the soldier's work experience or any part of it substantially meets the specifications of an occupation set forth in AR 615-26, he is classified according to the appropriate occupational title and specification serial number listed therein (items 13 and 14, Fig. 1).

If the recruit's work experience does not meet the specifications, the interviewer must refer to the United States Employment Service Dictionary for the appropriate title, in which case the recruit's occupational classification would not have an Army specification serial number indicating experience pertinent to a specific Army assignment. Very often a standardized oral or written trade test will be administered to assist in evaluating or verifying the knowledge and skill claimed by the soldier. When the proper classification has been determined, the appropriate title and, if it is an occupation of specific value to the Army, the specification serial number, together with a precise description of the duties performed, are entered on the card by the interviewer.

UPON completion of the interview and of the trade test, if given, the card is forwarded to a chief interviewer for review as to accuracy and completeness. It is then routed to a classifier who recommends the soldier for the type of duty in which it is considered he will be of most use to the Army. The classifier reviews Form No. 20, the information set forth thereon concerning the recruit's occupations, education, hobbies, leadership potentialities, nature of his previous military experience, if any, and the results of his test. Generally, occupational experience will be the most significant factor. On the other hand, if this experience is not particularly useful to the Army, hobbies such as photography or previous military experience as a machine gunner, for example, may be more important.

There also will be instances in which the classifier will feel that, although the soldier's main occupation does have some bearing on his military assignment, the skill indicated through the pursuit of a hobby is more urgently needed. For example, a carpenter with three years' experience may be recommended in his hobby as a radio operator, particularly so if the result of his radio operator's aptitude test was satisfactory, since radio operators are more urgently needed than carpenters. Always the classifier (but not the interviewer) must have the needs of the Army in mind. The classifier's recommended initial duty or training assignment is the only flexible item on the card, the only item that is changed according to the changing needs of the Army. The other items, such as main and second-best occupation, results of tests, educational history, etc., are objective facts and are unchanged, regardless of the particular duty for which the soldier may be recommended.

RECOMMENDATIONS are made in terms of the actual military occupations for which men are considered to have qualifications. For example, jewelers and refrigerator mechanics are not recommended as such but may be recommended for a duty or training assignment as instrument repairmen, gunsmiths as armorers, stewards as mess sergeants, etc. To take a different illustration, the soldier classified as a "lawyer," may be recommended as an "armorer" because of his hobby of repairing guns or demonstrated mechanical aptitude. The civilian supply of occupational specialists falls short of Army demands for certain skills. Furthermore, many Army specialties have no prototypes in the civilian economy. The differences must, therefore, be made up by locating and identifying related or potential skills which can most readily be converted into military specialties.

Many of the men entering the Army have had no previous experience or identifiable potential skill for which there is a counterpart in the Army. This is not to say that they have no qualifications for which the Army has use. On the contrary, they may have demonstrated in civilian life qualities of leadership vital to the Army. They may develop into potential Ordnance officers, noncommissioned officers, ammunition workers, or artillery mechanics, or they may possess combat ability to a rare degree. Nevertheless, not having specialized qualifications indicating that they should be assigned to any specified military duty or training, they are classified at the reception center as "nonspecialists" (521).

When the classifier has determined upon the assignment recommendations, he enters the title and specification serial number of the military occupation in item 26 of Form No. 20. The card is then forwarded to the coding and punching section where it is coded and punched on its perimeter, making possible quick mechanical sorting of a large number of cards according to any one or more of the facts on the card.

After coding and punching have been completed, the card is transmitted to the records and assignment section. Here tabulation is made of each man's classification in the reception center by specification serial number of the military specialty for which he is recommended. Each day a consolidated availability report is made over teletype to the service command headquarters.

Constantly coming into the service command from the Classification and Replacement Branch of The Adjutant General's Office in Washington are War Department requisitions designating the numbers of the types of specialists and of the nonspecialists by specification serial numbers to be sent to replacement training centers of the arms or services and to units in a training status. In the preparation of these requisitions, consideration is given not only to the specialized

needs of a single arm or service but also to the necessity for making a proportionate distribution as between specialists and nonspecialists to all arms and services. In other words, the ordinary Ordnance requisition will list a designated number of nonspecialists as well as specialists of particular value to Ordnance, such as instrument repairmen, mechanics, and armorers, and such specialists as cooks and clerks needed by all arms and services. Effort is made to meet the particular needs of any arm or service within the limits of the available supply and with due regard to the requirements of the other arms and services.

As these requisitions arrive at the service command headquarters, the classification officer matches them against the teletyped availability reports he receives from the reception centers of the command and determines which can most satisfactorily fulfill the requirements of the requisition. A directive is then issued to one or more reception centers to transfer the men accordingly.

In filling the requisition, the reception center naturally refers to the military duties for which men in the reception center have been classified and/or recommended. It is inevitable, however, that in many instances it will be short on some specialties and long on others. To meet the immediate shortage, men of reasonably related specialties are substituted. It should be borne in mind that the capacities of reception centers are limited. The egress of men must keep pace with their influx. Therefore, men with specialties seemingly qualifying them for a particular arm or service but of which the service command has an "overage" cannot be held over indefinitely pending the arrival of a particular requisition. However, those men with specialties in which there is consistent shortage are earmarked and held over for the appropriate requisition. The whole reception-center process of classification and assignment of the individual soldier is accomplished on the average within a period of from three to five days.

The classification process continues after the recruit has been assigned to a particular arm or service. For example, in the first week of the trainee's arrival at the Ordnance Replacement Training Center at Aberdeen Proving Ground, Md., he is reinterviewed by the Center's classification section. At the interview, the qualifications set forth on his Form 20 are carefully checked for accuracy and completeness. These qualifications are discussed with the soldier, particularly with respect to their bearing on the technical training assignment at the Training Center for which the soldier would seem to be most qualified. The training program is explained and interpreted especially in the light of his individual capabilities. Perhaps the recruit has done a lot of hunting and therefore has had occasion to develop a knowledge and hobby of gun mechanics, in which case, if the result of his mechanical-aptitude test so warranted, he might be recommended for the small-arms school. Or perhaps another recruit has been an optician or a jeweler or a watchmaker, hence, if his aptitude grades were high, he would make a promising recruit for the instrument-repair school. Also, the recruit may be potential noncommissioned officer material and so would be recommended for an interview before a board of officers. At the conclusion of the interview, the interviewer notes his recommendation on Form 20 and in the case of potential noncommissioned officers also submits a completed form detailing the individual soldier's qualifications for the information of the Officer Board.

In addition, those men who have important clerical qualifications are given a clerical-aptitude test to determine the best available to meet the limited quotas for the various clerical schools such as those for depot and supply, administrative, clerk-typist, etc.

RECRUITS received by the Ordnance Department who are either not capable of undergoing the regular training routine because of physical disabilities, emotional instabilities, or are not capable of absorbing technical training because of mental deficiencies, are screened out by the classification process for special training.

The Army's need for man power is urgent. It will not discharge any one who can be trained to become more of a help than a burden to the service. In order to make maximum use of the large number of limited-service men now entering the Ordnance Department, a special training unit has been established in the Replacement Training Center at Aberdeen. It has as its object the individual development and, in some cases, the actual rehabilitation of the limited-service soldier to a point of military usefulness.

Classification for limited service because of physical handicaps is, of course, the function of the medical authorities. However, it is the job of the personnel-classification unit to make sure that such men are placed in work of a type consonant with their limited physical capacities.

On the basis of Army general-classification test results, eight to ten per cent of recruits entering the Army are determined to be mentally retarded, illiterate, or unable to read the English language. Ordnance is receiving a proportionate share of this group. It is the function of the classification section of the Ordnance Replacement Training Center to screen out these cases for special training. Men coming into the Training Center who fell in the lowest group of the Army general-classification test are given a nonlanguage general classification test, administered solely in pantomine, to determine actual native ability to learn, irrespective of language difficulties. Those remaining in the lowest, or mentally deficient group are given an individual test to identify further their general mental capacity. At the same time they are reinterviewed and, in some cases, are also given a simple identification and memory test as well as a personality test. Upon the basis of these individual tests and reinterviews, recommendations are made for assignment to the special-training unit.

It is to be expected that among the masses of men now entering the Army there will be some with tendencies to emotional instability, inner conflict, strong inferiority complex, etc. Particularly are such tendencies likely to be accentuated in the process of attempting to make adjustment from civilian to military life. The classification officers of all headquarters, with the aid of personnel consultants who are specially trained in psychology, must be ever on the alert for the occurrence of any case in which abnormal psychological factors are operating or any case involving unusual personality traits. These cases must be singled out for special consideration, testing, and study.

In the fourth or fifth week of basic training of a regular training company, the classification officer reviews the qualification cards to make final decisions as to the technical training assignment of each man. Bearing in mind the technical qualifications and aptitudes required of students of each specialty, he reviews the experience, test grades, education, and the interviewer's recommendations set forth on the card. He has to sort and assign the potential special-

(1)-M NAME (PRINT CLEARLY) STERN (LAST NAME) MICHAEL (FIRST NAME) VLADMIR (MIDDLE NAME) | 12923327 ARMY SERIAL NUMBER | FT. 5 IN. 10 HEIGHT | LBS. 165 WEIGHT | W RACE

(2) BIRTHPLACE OF SOLDIER (GIVE CITY AND STATE OF U. S. OR NAME OF FOREIGN COUNTRY) New York, N.Y. HOW LONG IN U. S. ____ YEARS

(3) DATE OF BIRTH OF SOLDIER Jan. (MONTH) 11, (DAY) 1911 (YEAR)

(4) CITIZEN ✓ TAKEN OUT FIRST PAPERS ☐ NON-CITIZEN ☐

(5)-P MARITAL STATUS M NUMBER OF DEPENDENTS 1

(6) BIRTHPLACE OF FATHER (GIVE CITY AND STATE OF U. S. OR NAME OF FOREIGN COUNTRY) Russia

(7) BIRTHPLACE OF MOTHER (GIVE CITY AND STATE OF U. S. OR NAME OF FOREIGN COUNTRY) Russia

(8)-L EDUCATION

YEAR LEFT SCHOOL 1931 NON-E. L-7 ILLITERATE L-11

SCHOOL	Number of Years	GRADUATED YES	GRADUATED NO	NAME AND LOCATIONS OF INSTITUTIONS ATTENDED	MAJOR SUBJECT OR SPECIALIZATION	DEGREE AND DATE RECEIVED
L (SF1) GRAMMAR SCHOOL	8	✓		New York, N.Y.		
(SF2) HIGH SCHOOL	4	✓		New York, N.Y.	Academic	1928
(1-2) COLLEGE OR UNIVERSITY	2½		✓	Virginia Poly. Institute	Physics	
(4-1) POST GRADUATE						
(4-2) TRADE, NIGHT OR ~~CORRESPONDENCE~~ SCHOOL SEE (29)	2	✓		Bedford Y.M.C.A. Brooklyn, N.Y.	Machine Shop	Cert. 1933

(9)-M LANGUAGES (CHECK APPROPRIATE SPACES) S—SPEAKS R—READS W—WRITES

	SPANISH (9-38) S	R	W	FRENCH (9-36) S	R	W	GERMAN (9-37) S	R	W	OTHER LANGUAGES (9-38) Russian S	R	W	S	R	W
FAIRLY WELL											✓				
FLUENTLY (9-39)										✓					

(10)-P CORPS AREA ~~OR DEPARTMENT OF ENLISTMENT OR INDUCTION~~ II

(11)-L SPORTS IN WHICH QUALIFIED College (SCHOOL OR TEAM) EXCELLS ✓

TRACK L-SF-1 | BASKET BALL SF-4 | BOXING ✓ | BASE BALL ✓ | SOFT BALL 4-1 | WRESTLING 7-1 | FOOT BALL 2-1 | TENNIS 4-2 | OTHER 7-2

(12)-L TALENT FOR FURNISHING PUBLIC ENTERTAINMENT

MUSICAL INSTRUMENT L-27 Piano | SINGING L-28 | THEATRICAL L-29

(13)-M MAIN OCCUPATION (OCCUPATIONAL DICTIONARY CODE) Tool Maker 4-76.210 | TRADE TEST INDICATED ✓ | YEARS AT IT 8 | WKLY. WAGE $75.00 | SPEC. SER. NO. 241 | DEGREE OF SKILL SK. | (13) CIVILIAN M

JUST WHAT DID YOU DO? Operated precision machine lathes, millers, profilers, grinders, in construction, repair, sharpening, and calibration of tools, dies and jigs. Filed clipped, tapped, reamed and fit by hand. Used Micrometers, gages. Worked to .0005 in. tolerance. Set (See 28)

LAST DATE OF EMPLOYMENT May 1941

EMPLOYER (GIVE FIRM NAME - NOT NAME OF FOREMAN OR BOSS) Cameron Machine Co.

ADDRESS OF EMPLOYER (NUMBER) 100 (STREET) Washington St., (CITY) Brooklyn, (STATE) N.Y.

~~DEPT.~~ SHOP ~~OR BRANCH~~ Machine KIND OF BUSINESS Heavy Machine Mfg.

(14)-M SECOND BEST OCCUPATION Truck Driver, Light | YEARS AT IT 1½ | WKLY. WAGE $15.00 | SPECIFICATION SERIAL NO. 345 | DEGREE OF SKILL S-SK | (14) CIVILIAN M | TRADE TEST INDICATED

JUST WHAT DID YOU DO? Drove light truck in the house to house sale of dairy products.

(15)-L ADDITIONAL OCCUPATIONS, HOBBIES, ETC. RADIO L SF-1 | PHOTOGRAPHY L ½ Develops & prints

OTHER Airplane Model Making

(16)-L ARMY GENERAL CLASSIFICATION TEST FORM & DATE	GRADE - SCORE	(17)-L APTITUDE TESTS TEST NO.	GRADE - SCORE	(18)-L OTHER TESTS TEST	GRADE - SCORE
1B 6/11/41	II 126	MA-1 ~~I~~ II	I 132		
		CA-1	III 107		

(19)-L TRADE TEST RATINGS

SPEC. SER. NO.	SCORE
114	W 14/15

(20)-L HIGHEST POSITION OF LEADERSHIP (INCLUDING MILITARY) President of H.S. (2000 Students)

FIG. 1. THE SOLDIER'S QUALIFICATION CARD, A.G.O. FORM NO. 20 (FRONT)

ists according to the quotas established for each course based on the needs of the field. In other words, it is a process of adapting the supply to meet the demand. When the assignments have finally been determined upon, a report is mailed to The Adjutant General's Office and to the Office of the Chief of Ordnance in Washington of the number of men to be available at the end of eight weeks of technical training in the several military specialties in which they are trained.

In the meantime, requisitions flow from field units into the Office of the Chief of Ordnance for men according to the military specialties listed in current tables of organization. These requisitions are transmitted to The Adjutant General's Office which matches them against availability reports and accordingly issues a transfer order on the Ordnance Replacement Training Center listing the numbers of men in each specialty to be sent to various Ordnance units stationed in the field. The classification section, upon receipt of such an order, selects the particular men who have been trained in the military specialties designated in the replacement transfer order.

It should not be forgotten that the management of a modern army involves a continuous process of selection, placement, and replacement of man power. Classification at reception and replacement training centers constitutes merely the initial stages of the process. For example, when a group of Ordnance soldiers from the Ordnance Replacement Training Center arrive at their field posts, they must be assigned to specific military duties. This should, of course, be done with careful consideration to individual qualifications of each man, particularly the military specialties for which they were trained at the Ordnance Replacement Training Center. In the case of Ordnance regiments and battalions, the process also requires assignments in accordance with the specialized needs of constituent units, with due regard for the general desirability of a roughly proportionate distribution of mental abilities. All of this involves the interpretation of classification data on the soldier's qualification card (W.D., A.G.O. Form 20).

FORM 20 is available at all times to unit commanders for their information concerning the individual qualifications of the soldiers of their command. Men must be selected for officer training, cadre, and for special-service schools. On occasion they will be chosen for special missions, and to perform special services. Perhaps a photolithographer or some one who can operate a radio and speak Russian will be needed. Or perhaps some prisoners will be captured requiring the services of an interpreter. Possibly in some post far away from organized forms of recreation, the commander will want to arrange an entertainment program and therefore casts about for talent to put on a show. These are some of the needs which can be supplied quickly and comprehensively by recourse to a simple sorting and examination of the Form 20's.

Now let us suppose that the table of organization calls for certain additional specialists not on hand. They must there-

fore be requisitioned from the Office of the Chief of Ordnance. This should be done according to the specification serial numbers established for each specialty by classification regulations (AR 615-26). Consider the grim problem in the combat zone of determining the casualties and the resulting loss in skills. Suitable filler replacements must then be requisitioned by specification serial number of the special training required. The fate of modern armies often depends upon the caliber of its replacements and the ability to obtain them in the right place at the right time. Classification, through its qualification record system, is designed to facilitate this process.

To be of use, the qualification record must be properly maintained, for it is designed to be a cumulative record of the individual soldier's progress in his military career and, as such, to afford a composite picture of both his civilian and military qualifications. It follows the individual soldier wherever he goes, and, in addition, it should follow him in whatever he does. For example, the classification section of the Ordnance School is charged with the responsibility of following the careers of some 7,000 enlisted men at the school, including students, officer candidates, members of the staff and faculty, and replacement-pool men. It is the section's job to make the training and grades and the experience and skills they acquire at the school a matter of record; to set forth this training and experience as part of their qualifications for the information of all commands to which they may be assigned.

In order to simplify this information, to make it easily understood and readily sortable, each course the enlisted man may take and each principal duty to which he may be assigned is analyzed to determine the proper classification and specification serial number for entry on Form 20. For instance, upon successful completion of courses in the Ordnance School, men are transferred to their next station as "Instrument Repairman, Fire Control" (Specification Serial Number 922), "Tank Mechanic, Suspension and Power Train" (Serial Number 908), "Ammunition Noncommissioned Officer" (Serial Number 505), etc. In the same way, after three months on the job, the noncommissioned officer in charge of the morning-reports section of the personnel section becomes a "Personnel Noncommissioned Officer" (Specification Serial Number 816), and the soldier who is in charge of the toolroom at the machine shop becomes a "Toolroom Keeper" (Serial Number 242). This is noted on the Form 20 of each and is punched in the military specialty code field on its perimeter, according to the specification serial number, thus permitting ready selection of those trained in any given specialty at a moment's notice.

The classification data set forth on the Forms 20 of those at the Ordnance School are continually being reviewed by the classification section. In some cases, reinterviews or retests, or both, are found necessary to obtain more accurate and comprehensive information, often resulting in a reclassification. Inventories are maintained of the Ordnance School enlisted staff and faculty, as well as the school detachment, by main occupation, military specialty, education, classification and aptitude test grades, and other classification data as compared with current assignments (see AR 345-5). This affords a composite picture of abilities as compared with the way in which these abilities are being utilized. Through such inventories, important hidden talent has been uncovered from the obscurity of a "bull gang" and put to work in sections or units in which such talent is badly needed.

Of utmost importance is the caliber of men selected to attend enlisted or officer-training courses at the Ordnance School. Men should be selected for these courses according to their individual abilities to absorb the instruction for which they are selected. Form 20, in addition to a personal interview and actual supervision on the job, is invaluable for this purpose. To ascertain the quality of the selection job being done by individual units, the Form 20 of each entering student is studied with reference to the academic and practical requirements of the particular course for which he has been selected.

AN interesting new development was the inauguration, in May 1942, of a system of officers' and warrant officers' classification. (See AR 605-90, issued May 21, 1942, and AR 605-95, "Tentative," issued January 19, 1943.) The uniform record instituted for the purpose was the Officer's and Warrant Officer's Qualification Card (W.D., A.G.O. Form No. 66-1), a record which is very similar to Form No. 20. It also provides for information concerning promotions, entry on extended active duty, World War and C.C.C. military service, and each principal duty together with an efficiency rating by superior officers. It is designed to be a service-rating record as well as a general qualification card.

Forms No. 66-1 are prepared by the classification section of the Ordnance School for all school staff and faculty officers and company officers, officers reporting for active duty either to the Officers' Replacement Pool or the Ordnance School, and all officer candidates upon graduation. Classification is accomplished by means of interviews or questionnaires or both and, in the case of officer candidates, with reference to Form No. 20 already completed for them as enlisted men. The interview and classification procedure as well as that prescribed for making the entries on and punching the form are very similar to that prescribed for Form No. 20.

The Officer's and Warrant Officer's Qualification Card (Form 66-1) represents a substantial advance in the management of officer personnel in the field. Prior to its institution, the only records worthy of the name were temporary forms completed by the officers themselves and sent in to the corps area or the War Department. The only source of information for the commanding officer in the field with regard to officers of his command was the 201 file, which started anew at each post. No ready or standardized source of information as to the officer's civilian experience and education, his dates of promotion, his previous military experience, the type and quality of the work he did at previous posts, etc., was available. Form 66-1 is designed to meet this need. Not only will it facilitate sound selection and assignments but it will constitute a basis for promotions based on merit as determined by service ratings, thus enhancing general efficiency and *esprit de corps*.

Potential Ordnance men are scarce. Efforts to make the most of what we have must be carried on unremittingly. It is the goal of the classification system to make the most of what every officer and enlisted man individually can contribute in the service of his country. How close we can come to this goal will depend in large measure upon the extent to which field commanders utilize the proven advantages of the classification system.

EDITOR'S NOTE.—Readers are also referred to the article on "Ordnance Personnel Procurement," by Capt. Bernard B. Abrams, in the May-June 1943 issue of ARMY ORDNANCE.

Spoils of Victory

RECENT victories of our forces in Africa, the Solomons, the Aleutians, and elsewhere have resulted in the capture of huge amounts of German and Italian matériel as well as sizable quantities of Japanese equipment, much of it in usable condition. What becomes of all these enemy guns, tanks, armored cars, mines, bombs, ammunition, and other ordnance, not to mention motor transport and airplanes? Some of these weapons are immediately put to use against their former owners, particularly during the critical phase of a battle when supply may be irregular and all possible transportation and firepower must be brought to bear upon the enemy to decide the issue. However, the lack of sufficient spare parts and ammunition of the proper calibers, the difference in operating technique and ballistic qualities preclude the general use of this captured matériel, at least by an army as well supplied and equipped as ours.

But these enemy weapons do serve a useful and valuable purpose, as explained in the article by Col. Scott B. Ritchie on page 96 of this issue, and the Ordnance Department of the Army has set up a complete organization to collect, salvage, examine, classify, and store captured matériel. American Ordnance engineers are not hidebound. While our weapons have proved equal to or better than the enemy's, our technicians are continually on the lookout to discover new developments or manufacturing processes, and captured ordnance is studied for this purpose first of all. Examination also may reveal new tactical possibilities of an enemy weapon or disclose unknown weaknesses—information that will prove invaluable to our fighting men in their next encounter.

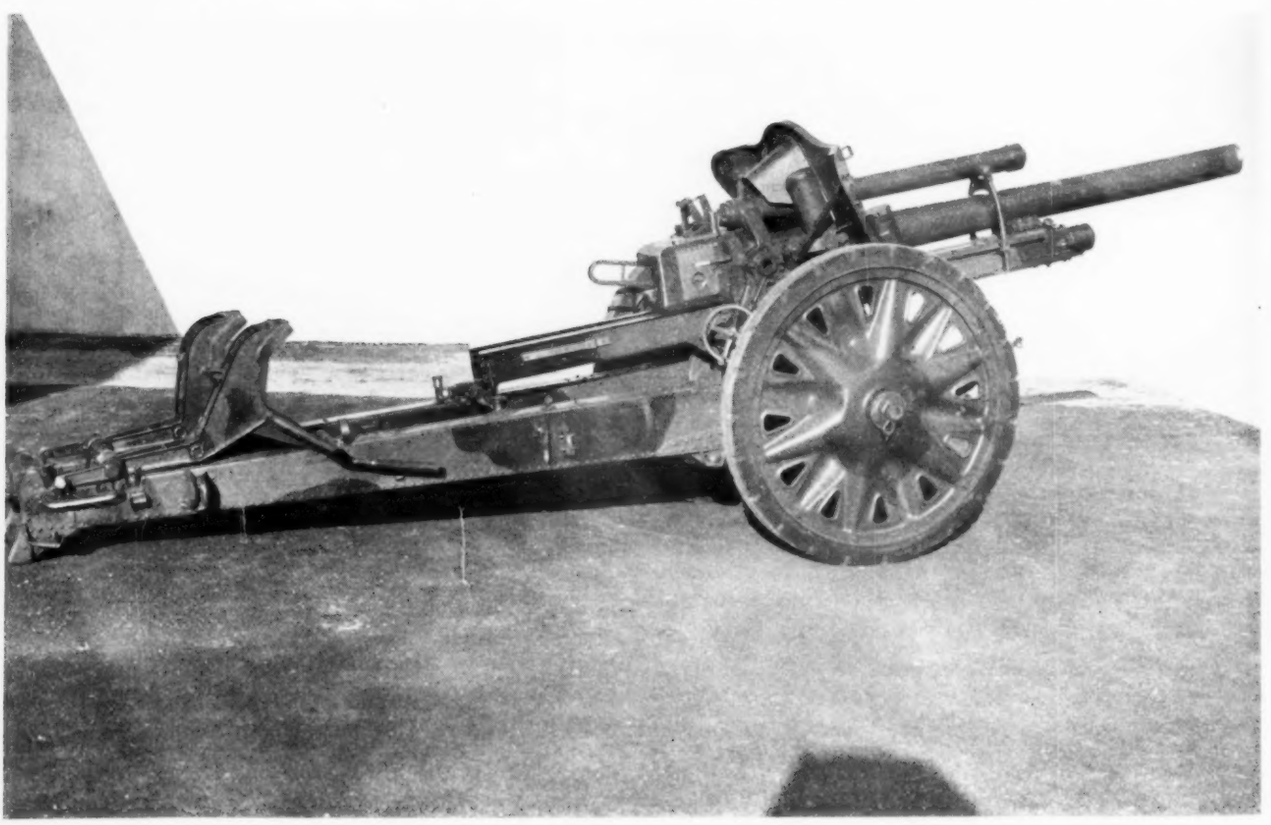
Analysis of enemy weapons also provides much interesting information on the enemy's internal condition, such as his supply of critical materials, availability of skilled man power, use of machine tools and modern metallurgical processes. However, the chief concern of those who must face these weapons is how far, how fast, and how hard they will shoot. This information is supplied by Aberdeen Proving Ground where enemy ordnance is constantly tested.

Among noteworthy captured German weapons are: the machine gun, MG 42, in which stamped metal parts have replaced many forged and machined parts of the earlier model; the 28/20-mm. tapered-bore gun firing a compressible projectile at a very high muzzle velocity effective only at short ranges; a 75-mm. recoilless gun of very light weight suitable for accompanying air-borne or parachute troops. Italian guns, except the Breda machine gun, are much inferior to the German weapons, while Japanese ordnance is usually a mediocre copy of foreign models.

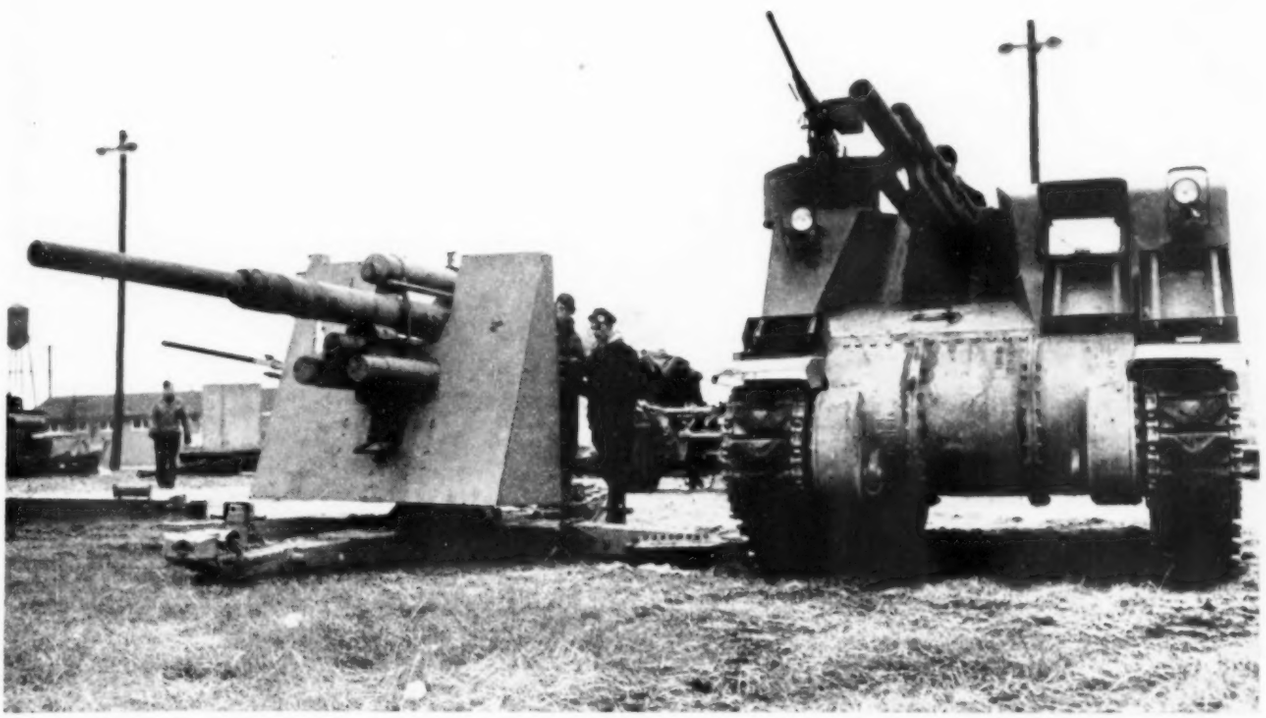
While many ingenious devices have been discovered on enemy weapons, it is safe to say that the very great majority of them were known and tested by the Ordnance Department years ago. Without doubt, "when better weapons are made, U. S. Army Ordnance will make them." (Accompanying illustrations of enemy matériel are from U. S. Army or British official photographs.)

German Heavy and Light Artillery

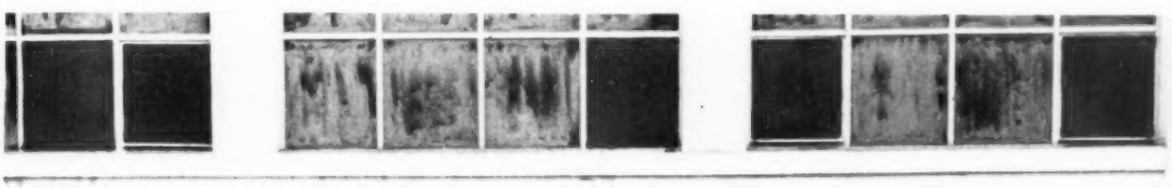
Above is a German 170-mm. long-range gun captured by the British in Tunisia during the advance northward from Gabes. Note the boxlike trail, solid-tired wheels, and carriage jacks. Below is a captured German 105-mm. LFH 18 howitzer shown in traveling position. This is the standard divisional field artillery piece of the German Army. Note folding spades.



Enemy Antiaircraft and Antitank Guns



An 88-mm. German antiaircraft-antitank gun is shown at the left, above, next to an American M7 tank destroyer mounting the 105-mm. gun-howitzer. The 105 showed itself the heavier hitting weapon in battle. Below is a German 75-mm. Pak 40 antitank gun which proved to be a scaled-up version of the 50-mm. Pak 38. Note muzzle brake and tubular trails.



German Tanks—Mks. III and IV

Above is a German Pz. Kw. Mk. IV medium tank weighing 22 tons, armed with a 75-mm. tank version of the 75-mm. Pak 40 antitank gun and one 7.92-mm. (cal. .312) machine gun, MG 34, mounted coaxially. Below is a German Mk. III tank captured in Tunisia. Note the low silhouette, high-velocity gun, and grousers attached to front to give added protection.

Enemy Tanks—Heavy and Light

Above is the much-touted German heavy "Tiger" tank, Pz. Kw. Mk. VI, weighing 62 tons and armed with an 88-mm. KWK 36 tank version of the 88-mm. antiaircraft-antitank Flak 18 and one 7.92-mm. machine gun. Our standard medium-caliber antitank guns had no trouble stopping these vehicles. Below is an Italian M13 light tank, of mediocre construction.

German Wheeled Vehicles

The German 8-wheeled armored car, above, is armed with a 75-mm. low-velocity tank gun and is equipped with dual controls for operation in either direction. At right, below, is a German Volkswagen alongside an American jeep. Intended originally as a "family car" the German vehicle has only 2-wheel drive, low speed, and is of very light construction.

Captured Half-Track Vehicles

The German armored half-track personnel carrier, above, has been equipped with a small antitank gun for use as a tank destroyer. Note the frontal silhouette and unusual bogie arrangement. The Axis prisoners shown in the illustration below surrendered of their own accord, coming in with their half-track motorcycle and trailers for transporting supplies.

Lost by the *Luftwaffe*

The airplane above is a German Focke-Wulf 190, one of the Luftwaffe's newest single-seater fighters. Forced down in England by lack of fuel, it was repainted with R.A.F. markings and given exhaustive tests by the British. Below is shown one of the many dumps of German bombs captured in North Africa during the victorious advance of the United Nations.

Decius Wadsworth

First Chief of Ordnance, U. S. Army, 1812-1821 (Part II)

By Col. C. Wingate Reed

FROM the fall of 1813 until the following summer, Col. Decius Wadsworth, the first Chief of Ordnance, spent much of his time inspecting fortifications and sites from the James River to the upper reaches of the Chesapeake. His years of experience in the Corps of Engineers well qualified him for this work. Col. Jonathan Williams had again quarreled with the War Department over his right to command Castle Williams on Governors Island and had again resigned, so it was but natural that Colonel Wadsworth's advice would be sought. His letters to the Secretary of War during this period contain much sound advice which, had it been followed, probably would have produced far different results when Washington was attacked. However, little action actually was taken to benefit from his surveys and recommendations.

Another far-reaching result of this raid and blockade was in the field of transportation. Colonel Wadsworth, in locating each arsenal or laboratory for construction or supply, had carefully considered the question of transportation, particularly with reference to overland portage and the safety of water transportation in the event of a blockade—"the principal deposits for cannon . . . to be on or near the Chesapeake . . . from whence the wants . . . may be supplied without much land carriage or a great risk even in time of war."[8] He had carefully computed the distance for wagon transport between the various arsenals and principal cities, considering inland waterways where available. This method of transportation quickly appealed to the nation, and a new industry was launched. The roads throughout most of the country creaked and groaned by day and night with heavily loaded wagons. It is estimated that by the summer of 1814 there were four thousand wagons and twenty thousand horses and oxen engaged in this trade.[9] Trips were made from Boston all the way to Augusta, requiring two months for the trip.

During this period much uneasiness was felt for the safety of Alexandria and the Capital. In May 1813, a delegation of prominent citizens of Alexandria called upon the Secretary of War for additional fortifications to defend the Potomac. Colonel Wadsworth was directed to confer with the committee, examine into their suggestions, and report upon them. He personally inspected the defenses at Fort Washington and found them, with minor alterations, to his satisfaction. He reported: "The batteries of Fort Washington are in such a state, and so effectively command the channel of the Potomac that it is not apprehended the enemy will attempt to pass it while its present defense remains entire. . . In case of designs against the District of Columbia, an assault by land is most probable."[10]

The spring of 1814 brought renewed uneasiness regarding the Potomac defenses, and again Colonel Wadsworth visited Fort Washington. To calm the fears of the citizens of Alexandria, and more probably to assure a loan which the Government was negotiating with these citizens, additional cannon were mounted at Fort Washington, the gun platforms were widened to assure better service of the pieces, and more ammunition was supplied from the arsenal at Greenleaf's Point.

After the destruction and abandonment of Fort Washington, upon the approach of the British ship SEA HORSE on August 27, 1814, an attempt was made to place responsibility for this disgraceful conduct upon a lack of cannon and ammunition. A congressional investigation which followed developed the fact that more than ample cannon and ammunition were on hand for a prolonged defense.[10]

REGARDING the part taken by Colonel Wadsworth in the inglorious defense of Washington in August 1814, there seems to be some confusion. That he actually constructed the few emplacements and breastworks that were constructed, there is little doubt. Gen. Tobias E. Stansbury, commanding the drafted Maryland Militia at Bladensburg, said: "On arriving at the orchard near the mill, I directed the artillery to post themselves behind a small breastwork of dirt that lately had been thrown up by Colonel Wadsworth."[10]

Two letters in the War Department files, addressed to Colonel Wadsworth, give directions for the emplacement of certain militia artillery. In this period, the most notorious in the history of the United States for its military failures, its lack of inspired leadership, and its utter confusion, it is more than probable President Madison and Secretary Armstrong gave many duties and responsibilities to this practical engineer and experienced artilleryman that were far beyond the responsibilities which would normally have fallen upon the Chief of Ordnance. That he commanded the guard at the Virginia end of the bridge over the Potomac was brought out during the congressional investigation. Captain Morton, Colonel Wadsworth's assistant, said: "Having been personally conversant with Colonel Wadsworth on the evening of the day of the Battle of Bladensburg, and on the subsequent invasion of the city, the Colonel at no time suggested to me, *though the next officer in command,* the necessity or expediency of firing the Potomac bridge."[10]

The *American Daily Advertiser,* a Philadelphia paper, under date of September 2, 1814, in an article describing the burning of Washington and the subsequent capture of Alexandria by the British, recounts a disagreement between James Monroe, Secretary of State and Acting Secretary of War, and Colonel Wadsworth. The account states: "[Monroe] Noticing that Colonel Wadsworth was placing some guns on the Virginia shore, ordered him to desist. This Wadsworth refused to do. Monroe, in heat, bade him obey or leave the field."[9]

This episode, in substance, is unquestionably true. Monroe's influence on Madison is well known. He unhesitatingly meddled in the affairs of every one—riding out to the Battle of Bladensburg where he made suggestions, criticized, and

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This is the second and concluding installment of this article. Part I appeared in the May-June 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 138, p. 527).

8. References pertaining to both installments are published in full on page 116 of this issue.

gave orders in a situation already muddled beyond relief. To Colonel Wadsworth, disgusted with the inefficiency of those in authority and their lack of ability and leadership, this criticism by Monroe, whom he considered a meddlesome outsider, was the final straw. On September 10, 1814, he wrote Monroe, who by that time had succeeded in ousting Armstrong and taking his place as Secretary of War, and submitted his resignation. He wrote: "Feeling a strong disinclination to continue longer in the service of the United States in the Ordnance Department, I beg that my resignation may be accepted. . . Unaccustomed as I have been to endure reproaches, I should feel very impatient of them, if unaccompanied by a consciousness of their being unmerited. My health besides is too much impaired to allow me to make great exertions. . . My designs ever since I took charge of the Ordnance Department, with the exception of some intervals, [have] been checked and controlled so as nearly to frustrate my plan." [11]

By this time Colonel Wadsworth's ulcerated finger had become cancerous, although this is the first mention of its affecting his work. For some time friends and surgeons, including Dr. James Tilton, the Physician and Surgeon General of the Army, had insisted upon an amputation, but this Colonel Wadsworth stubbornly refused to permit.[2]

BUT Wadsworth was too valuable to lose at this time. The National Government was bankrupt and in ill repute. The states were forming their own armies and preparing for their individual defense. On September 17th, Monroe wrote Wadsworth: "It was not my desire or thought by the calls which I have been forced to make on you to cause your resignation. . . You are hereby authorized to retire into the country on furlough for the benefit of your health. . ." [11]

Colonel Wadsworth accepted the offer of a furlough, withdrew his resignation, and returned to Connecticut for a much-needed rest. Captain Morton carried on his work in Washington until about December 1, 1814, when Major Bomford arrived and assumed the duties of Acting Commissary General. Colonel Wadsworth was recalled to duty as a witness at a general court-martial at Utica, N. Y., on January 3, 1815,[13] but did not return to Washington until after the news of Jackson's victory at New Orleans, and Henry Carrol had landed at New York with tidings that the war was over.[9]

The reorganization act of February 8, 1815, made the Ordnance Department a part of the permanent military establishment and defined its duties and responsibilities. The commissioned personnel consisted of one colonel (Chief of Ordnance), one lieutenant colonel, two majors, ten captains, and twenty lieutenants. Although Monroe was still Acting Secretary of War, Colonel Wadsworth was selected as the first chief of the new department of the Regular Army. He accepted the appointment, but did not return to Washington until after April, when A. J. Dallas had been appointed to the office of Secretary of War.[8]

The act of 1815 called upon the Chief of Ordnance, under the direction of the Secretary of War, to draw up a system of regulations to insure uniformity in the public armories and in the manufacture of ordnance. This act also placed the Springfield and Harper's Ferry Armories under the control of the Ordnance Department for the first time.

These new provisions coincided entirely with Colonel Wadsworth's ideas. One of his first acts under his new appointment was the preparation of plans to standardize the small arms in the service.[8] Throughout the war the heterogeneous congeries of weapons of all calibers had been a source of great annoyance to him, creating a difficult problem in the supply of repair parts and ammunition. Reporting to the Secretary of War on his proposed plans he said, "Uniformity is in itself an advantage to supersede all innovations and pretended improvements." [8]

He also renewed his efforts to get reports from all posts and forts of the matériel on hand and initiated steps for the collection, repair, and proper storage of all surplus ordnance matériel, including small arms, for which the Government had expended many millions during the war.[8]

After conferring with the leading small-arms experts of the day, including Mr. Stubblefield, the superintendent of the Harper's Ferry Armory; Mr. Prescott, a former superintendent of Springfield Armory; Lieutenant Colonel Lee, superintendent, and Eli Whitney, owner of the Whitneyville Armory and a large Government contractor, he prepared specifications for the various weapons. Muskets and pistols were to be the same caliber. The rifle was to be standardized with a smaller bore. Barrel lengths were standardized for each type of weapon, and only one type of bayonet was to be made for both the rifle and the musket. The French musket, model of 1763, known as the Charleville musket, had been used as a pattern for the Springfield musket. Whitney, noting the improvements made in the model 1777 French musket, had incorporated many of these improvements in the Whitney musket. A lock, similar to that on the 1777 French musket, was standardized for both the new rifle and the new musket.[8]

Colonel Wadsworth was an enthusiastic admirer of the model 1777 French musket and it was on this subject he made one of his few overstatements—one that often has been quoted when commenting on the folly of prophesying as to the future development of mechanical devices: "The model of 1777 [musket] resulting from the gradual improvements suggested by the experience of above a hundred years in that warlike nation, we may rest assured is exempt from every essential defect, and perhaps not susceptible of any further improvements." [8]

COLONEL WADSWORTH was a friend of long standing and a great admirer of Eli Whitney. Seventeen years before, shortly after regaining his captaincy in 1798, he had been appointed an inspector of muskets fabricated in the East. This appointment, made by the Treasury Department, which was at that time responsible for the procurement of arms, was dated December 28, 1798.[14] The assignment carried Wadsworth to Whitneyville, where Whitney's factory was located, and there they became acquainted. Whitney then was endeavoring to obtain a Government contract, and his theory of uniformity and interchangeability of parts greatly interested Wadsworth. In 1800, Wadsworth gave Whitney a letter to the Secretary of the Treasury, recommending his ability and facilities. Later, in writing of Whitney and his earlier difficulties in establishing his system of repetitive manufacture, Wadsworth said: "His abilities [were] not so generally known and acknowledged then as they since have been. . . Feeling confident myself . . . I used all my influence to confirm the officers of the Government and the public mind in his favor." [8] Wadsworth felt, and freely stated, that Whitney had the most perfect and complete manufacturing plant existing in the United States at that time. He was equally convinced the manufacture of arms was more indebted to Whitney than to any other individual in

America.[8] It probably was Whitney's esteem for the model 1777 French musket that caused Colonel Wadsworth to become so enthusiastic on the subject.

The construction of arsenals, magazines, and laboratories was an important activity under Colonel Wadsworth. Springfield Armory and Harper's Ferry were in operation before the war but did not come under Ordnance control until 1815. Greenleaf's Point Arsenal, later Washington Arsenal, was Government-owned prior to the war and was greatly developed during Wadsworth's period in office. When the British captured Washington, this arsenal was partially destroyed when a British soldier threw a lighted torch into a pit in which black powder was stored, believing it to be a well.

THE arsenal at Pittsburgh was built under Colonel Wadsworth's direction, as was the arsenal at Albany. This arsenal, later known as the Gibbonsville Supply Depot and Arsenal, is now Watervliet Arsenal. In selecting the site, Wadsworth again came into conflict with General Dearborn, who then was commanding the Northern Army. He felt the location of this arsenal was his responsibility and that Dearborn was meddling. He wrote the Secretary of War: "I should desire, before these agreements be finally concluded, to know where the grounds are situated . . . especially as I know General Dearborn was desirous of fixing on a spot to which I had objection." [5]

Frankford Arsenal, then referred to as "a depot on Frankford Creek, near Philadelphia," was established in 1814. Watertown Arsenal, on the Charles River above Boston, was started in 1816, and Augusta Arsenal followed in 1817. A number of lesser magazines and depots also were constructed under Colonel Wadsworth's supervision, including an arsenal on the James River, near Richmond. In fact, during the period that immediately followed the close of the war, an overly generous Congress was desirous of building a great many other arsenals. This action was strenuously opposed by Colonel Wadsworth, who said, "It would be injudicious to commence building so many new arsenals at once . . . a greater portion of our means should be reserved for providing the more important articles of military stores." [8] Colonel Wadsworth recommended six principal arsenals [8] and an additional six or eight subsidiary arsenals. Of the six "old-line" manufacturing arsenals now operated by the Department, three were established by Colonel Wadsworth, and a fourth, Springfield, came under Ordnance control while he was Chief of Ordnance.

Though a man of quick decisions, firm convictions, and outspoken opinions, Colonel Wadsworth, when convinced of an error in judgment, did not hesitate to reverse his decisions. In 1813 he bitterly opposed the use of cylindrical shell (oval), and made considerable effort to prove the shell had an irregular rolling motion in flight and struck obliquely, "neither exactly with its end or side." [8] However, Lieutenant Colonel Bomford was convinced of the value of this type of shell, and five years later Wadsworth was enthusiastic for the elongated shell which Robert L. Stevens of Hoboken, N. J., made by a "secret process." These shell were for 18-, 24-, and 32-pounders and were proof-fired for an acceptance test.

Such modern problems as war reserves, balanced stores, and adjusted contracts all are included in Colonel Wadsworth's correspondence with the Secretary of War or members of Congress. Lead for bullets, timber for gun carriages, and straight-grained beechwood for fuzes were included in items he recommended for purchase and storage, "if it can be done without sensibly affecting the market." [8]

Early in 1813, when demands on the new Department were great and much difficulty was encountered in getting the proper cannon, carriage, ammunition, and other supplies to the proper place at the proper time and in proper condition, Colonel Wadsworth had propounded the doctrine of balanced stocks. "Let the ordnance and ordnance stores for armies in campaign leave the arsenals in divisions of six or eight pieces of cannon with a complete assortment of stores, spare articles, etc., to each division," [8] was his recommendation.

At York, Pa., a place he favored for the manufacture of cannon carriages because of the ample supply of good timber, low wages, and skill of the wheelwrights, Colonel Wadsworth proposed an adjustable contract. His proposition was not too far removed from our modern "educational order." On this subject he wrote: "As the workmen at York are not much acquainted with that sort of work [making gun carriages], they would with reluctance consent to name a certain price before they could ascertain by experience the actual labor attending the construction. I thought it best to agree the bills should be submitted to two disinterested persons, one on their part and one on the part of the Government, that they might rest secure of a fair compensation and the public be insured against exhorbitant charges. After a few carriages shall have been constructed a more definite agreement as to price, if thought necessary, can be established." [8]

ARTILLERY was probably the greatest single source of annoyance and controversy that Colonel Wadsworth encountered during his tour as Chief of Ordnance. Prior to the creation of the Ordnance Department, the Corps of Artillery had been responsible for the design, procurement, supply, and maintenance of their own weapons. Quite naturally they resented the loss of control over these functions. From his first days in office, Wadsworth had anticipated difficulty with the Artillery over the division of responsibility and had endeavored to have the War Department definitely state where Ordnance responsibility left off and Artillery responsibility began. This was particularly essential in field maintenance where quite often the only available mechanics were artillerymen.

The Gribeauval or French type of artillery gradually had replaced the British type of cannon used by the American Army during the Revolutionary War and by 1812 was the standard weapon in the service. However, in making the swing to the French weapon, the American artillerists had overlooked the cardinal virtues of the Gribeauval system—standardization and interchangeability.

It was obvious to Colonel Wadsworth that in adopting the French type of artillery, without adopting the entire Gribeauval system, the Americans had missed the greatest advantage offered. The vast number of calibers in the American artillery and the different types or models within each caliber were a source of great annoyance to him. On the theme of simplicity and standardization he wrote: "Simplicity and uniformity are all-important and are so well understood in the French service that the form and dimensions of the most minute article appertaining to the artillery are settled by precise regulations, from which no departure is tolerated." [8]

While the American Artillery gradually had been adopting the French cannon and carriages, the British had been

greatly improving their matériel. During the war there was little opportunity to compare the artillery of the American Army with the new British matériel, but the discerning eye of Colonel Wadsworth noted a number of points in which he believed the British carriage to be superior. He had a new British carriage, which had been captured in 1814, sent to Washington Arsenal. Using this as a model, he designed a gun carriage which he believed to be superior to either the French or British.

It was his effort to have this carriage accepted as the American standard that launched his greatest controversy. In this endeavor he met opposition both from the Artillery and from his own Corps. The name Gribeauval carried too much weight and prestige in the minds of American Artillery and Ordnance officers to be discarded. When writing to Mr. Calhoun, then Secretary of War, Colonel Wadsworth defended his departure from the old design, saying, "We should lose a great deal and expose ourselves to derision in the minds of those who know how carriages ought to be built, to servilely copy French patterns invented fifty or sixty years ago. It is a mistake to suppose the French system of artillery is the most perfect in existence. . . The British artillery is now superior to what the French ever was."[15]

IN the controversy which accompanied the design of the new carriage, Secretary Calhoun appointed a board of officers to examine and report upon the merits of the Wadsworth carriage.[15] This was perhaps the first Artillery Board ever appointed in the United States (July 28, 1818). The Light Artillery, Corps of Artillery, and Ordnance Department all were represented. This board found unfavorably for the Wadsworth carriage and the controversy continued unabated. Capt. William Wade of the Ordnance Department, a member of the board, writing nearly fifty years later on the merits of Colonel Wadsworth's carriage, said: "This was the first field-gun carriage of the stock-trail model that I ever saw or heard of and was doubtless the first ever known in the United States."[15]

Birkheimer in his "Historical Sketch of the Artillery, United States Army," although defending the artillerists' cause in the dispute over the control of matériel, pays fine tribute to the perception and ability of Colonel Wadsworth and laments his failure to live long enough to witness his vindication. He writes: "The Colonel of Ordnance only, of the artillerists in this country, took in . . . the great superiority of the English system . . . something the French Government . . . did not acknowledge until ten years later. He lived before his time . . . twenty years afterwards his associates and opponents acknowledged he had been right."[15]

None realized more clearly than Colonel Wadsworth that he was fighting a losing battle. The Artillery was in the ascendant, a wave of economy again was sweeping the country, and Congress was demanding a reduction of the Army to a paltry 6,000 men. Under this guise of economy the Artillery sought to abolish the Ordnance Department. They found a penny-pinching Congress ready to abet them.

Colonel Wadsworth, stinging under the attempts of the Artillery to force measures upon the Ordnance Department, wrote, with his usual clarity and forcefulness: "The opinions and suggestions of officers of experience belonging to these corps [Light Artillery and Corps of Artillery], men of science and of practical knowledge, ought to be received and treated with great deference and respect, and without doubt would be by the Ordnance Department. But it is one thing to listen to the suggestions of others and allow them just weight and influence, and another to be obliged to yield them implicit obedience."[8]

Secretary Calhoun supported Colonel Wadsworth in his fight to retain the Ordnance Department as a separate organization. "Economy is certainly a very high political virtue . . . but by no propriety of language can that arrangement [merging the Ordnance in the Artillery] be called economical."[8] But neither the oratory of Calhoun nor the logic of Wadsworth was of avail in this losing fight. In March 1821, Congress finally enacted the bill which ended the short but hectic life of the Department as a separate entity and again brought it under the control of the Artillery.

It was with relief that Decius Wadsworth accepted his discharge from the service, laid down the heavy burden of office he had so ably carried, and returned to private life. The cancer which had started so innocently as a wart on his finger had now spread through his entire arm and side. His suffering was intense, and he undoubtedly realized he had but a short time to live.

Upon retiring from the service he returned to New Haven, the scene of his youthful triumphs and the home of his younger brother. The better part of his life had been dedicated to the service of his country, and with the wholehearted zeal which characterized his entire life he had striven to perpetuate the Ordnance Department as a separate organization. Many of his assistants lived to see the Department revived and witness the complete exoneration of the Wadsworth ideas and theories, but, broken in health, he survived the merger of his Department but a few months.

Decius Wadsworth was a wanderer all his life. Although he achieved much distinction, commanded his own Department, was an exceptionally well educated and financially independent man, and was considered one of the most eligible bachelors in Dolly Madison's court, he never married. He died on November 8, 1821, in New Haven, and was buried in the old Grove Street Cemetery there, in a lot belonging to the family of his brother Sidney's wife.

A simple stone bearing the inscription, "Colonel Decius Wadsworth, late Chief of the Ordnance Department in the Army of the United States, who served his Country faithfully and without reproach for 20 years, died November 8, 1821, age 54 years," marks the final resting place of the pioneer Chief of Ordnance.

REFERENCES.—The following records, among others, were read and referred to in the foregoing biography of Colonel Wadsworth:

[1]Gray, "Record of the Descendants of John Clark, of Farmington, Conn." [2]Washington *Daily National Intelligencer,* 1814-1821, particularly December 8, 1821. [3]Ganoe, "History of the United States Army." [4]Wadsworth file, War Department records. [5]Wadsworth correspondence with War Department, U. S. Archives. [6]Occasional Papers No. 16—Engineer School. [7]Jonathan Williams file, War Department records, U. S. Archives. [8]Ordnance Department Reports (original), Vol. I. [9]McMasters, "History of the People of the United States." [10]State Papers, Military, Vol. I. [11]Monroe Papers, U. S. Archives. [12]Historical Register and Dictionary of the United States Army—Vol. I. [13]D. Parker, War Department files. [14]Blake, "History of Hamden, Conn." [15]Birkheimer, "Historical Sketch of the Artillery, United States Army."

Quality through Inspection

Standardized Control Methods Insure Acceptable Ordnance Matériel

G. Rupert Gause

QUALITY control is a term which one now sees and hears in practically all fields of industry. Toothpaste advertisements feature it, technical journals abound in articles on the subject, and leading universities offer special summer courses in its theory and application. In view of the sudden widespread growth of its use, it is not surprising that different meanings and connotations have become associated with this term and that there is no single generally accepted definition for it.

The Ordnance Department has recently completed, for representatives from its various establishments, a series of training conferences termed "quality-control conferences" and has appointed in each Ordnance district office and in each matériel operating branch of the Industrial Division, Office of the Chief of Ordnance, an officer or civilian to be responsible for the application of quality-control principles to the inspection of ordnance matériel. Here the term "quality control," has been used by the Ordnance Department to mean the scientific arrangement of inspection procedures and the efficient use of inspection results.

The above definition implies two things: first, that different arrangements of inspection procedures are not all satisfactory and, secondly, that there are inefficient ways of using inspection results. If these implications are correct, it is obvious that the Ordnance Department has an immense job in planning its inspections. Millions of dollars worth of ordnance matériel is being delivered every day, and Ordnance must decide whether any portions of this matériel are unacceptable and, if so, what particular portions. In order to do this, it must perform thousands of inspections involving the consumption of many hours of valuable and highly skilled man power. Anything which can be done to improve the efficiency of Ordnance inspection or to reduce the man power required for it is highly desirable. This is the aim of the quality-control program of the Ordnance Department.

Perhaps the best way to describe how this aim is being achieved is to enlarge upon the above definition of quality control and to indicate more precisely just what is meant by, first, the "scientific arrangement of inspection procedures" and, secondly, the "efficient use of inspection results."

An integral part of any Ordnance contract is the specification for the matériel concerned, and any matériel delivered under the contract should conform with all requirements of the specification. However, in general, specifications define what is wanted rather than what operational procedure must be followed to determine whether a particular delivery of matériel is acceptable. For example, such things as dimensions, finishes, and weights of matériel produced in large quantities are usually given on drawings, but no procedure is given for determining the acceptability of a batch of such matériel. Or again, the specification may use a phrase such as, "the inspector shall assure himself that the moisture content of each lot does not exceed the amount prescribed." Sometimes the sample size to represent a definite unit of production is prescribed, but the manner of selecting the sample is not. Or the specification may prescribe the method of test but leave it to the judgment of the inspector as to whether such a test is necessary. In any event, considerable judgment must be exercised in deciding what the operational procedure is to be in order to decide whether or not the requirements of the specification are met. This is as it should be, because the proper procedure may differ for matériel of one design made at different facilities, or even from month to month at one facility, depending upon production conditions. It is an inspection problem to decide just what this proper procedure should be.

BEFORE the present procurement program was put into operation, there were sufficient experienced inspectors available to have at least one of them at each producing facility. These men decided what sampling procedures and what acceptance criteria they would use. With them, inspection was an art rather than a science. Being experienced and tried men, they attained satisfactory results in most cases.

However, enormous increases in production volume and a concurrent draining of man power to other war needs have created a serious scarcity of experienced inspectors. It will probably be necessary for the remainder of the war to use most of the available experienced inspectors on those types of matériel purchased in relatively small quantities from scattered sources or those types requiring considerable judgment on the part of the inspector. In these cases, the inspector himself will have to continue to assume more or less complete responsibility for his procedures and for the quality of the matériel which he accepts.

This leaves few experienced inspectors for those types of matériel purchased in large quantity from relatively few sources, and here is where a scientific arrangement of inspection can be applied to advantage. Detailed procedures can be prepared covering the sample sizes to be taken as representative of a definite unit of production, the manner in which samples are to be inspected, the criteria for accepting or rejecting the matériel represented by the sample, and the records which are to be kept and submitted for analysis. In this way, responsibility delegated to less-experienced inspectors can be limited to following the prescribed inspection procedure and to insuring that specified processes are followed in manufacture.

Such detailed procedures should be prepared by men who know something about the production, inspection, and use of the matériel in question and who have imagination enough to be able to see a new and simple way of making an inspection. In this work, several heads are better than one, and the several heads should represent engineering, production, and inspection interests. Results of past inspection and reports on service use should be studied in order to determine where inspection effort should be concentrated, and methods of gaging and testing should be reviewed in order to select the simplest and quickest procedure. In short, all available

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Sublot Size		500–799		800–1,299		1,300–3,199		3,200–7,999		8,000–21,999		22,000–109,999		110,000 and over		Maximum A.O.Q.L. (Per cent defective)
First Sample Size		50		75		100		150		200		300		500		
Second Sample Size		100		150		200		300		400		600		1,000		
Acceptable Quality Level (Per cent defective)		Acceptance Numbers		Acceptance Numbers		Acceptance Numbers		Acceptance Numbers		Acceptance Numbers		Acceptance Numbers		Acceptance Numbers		
Major	*Minor*	c_1	c_2	c_1	c_2	c_1	c_2	c_1	c_2	c_1	c_2	c_1	c_2	c_1	c_2	
.010–.020	.....	*	*	*	*	*	*	*	*	*	*	*	*	0	1	.08
.021–.030	.010–.020	*	*	*	*	*	*	*	*	*	*	0	1	0	2	.15
.031–.060	.021–.030	*	*	*	*	*	*	*	*	0	1	0	2	1	3	.20
.061–.10	.031–.060	*	*	*	*	*	*	0	1	0	2	1	2	1	4	.30
.11–.15	.061–.10	*	*	*	*	0	1	0	2	0	3	1	3	2	5	.40
.16–.25	.11–.15	*	*	0	1	0	2	1	3	1	4	2	5	3	7	.60
.26–.50	.16–.25	0	2	1	2	1	3	2	4	2	7	3	8	4	13	1.0
.51–1.0	.26–.50	1	3	2	4	2	6	3	9	4	11	5	13	7	23	1.7
1.1–2.0	.51–1.0	2	4	3	5	3	8	5	13	6	16	8	25	14	40	2.7
2.1–3.0	1.1–2.0	3	5	4	8	5	11	7	18	9	24	12	35	†	†	3.7
3.1–4.0	2.1–3.0	3	9	5	11	6	16	9	23	11	32	16	47	†	†	4.2
4.1–5.0	3.1–4.0	4	10	6	14	8	19	11	28	14	37	†	†	†	†	5.3
.....	4.1–5.0	5	12	7	17	10	23	14	33	18	44	†	†	†	†	6.5

*Table not applicable in this region. †Use sample size in first columns to left in which acceptance numbers are shown for acceptable-quality level involved.

TABLE I. NORMAL LOT-BY-LOT ACCEPTANCE INSPECTION

Procedure for Major Defects.—(1) Select first sample of size indicated in Table I for sublot size involved; (2) Determine in first sample the number of articles, d_1, which contain major defects. (*a*) If d_1 does not exceed the c_1 indicated for the acceptable-quality level (major) involved, pass the sublot for majors; (*b*) If d_1 exceeds the corresponding c_2, reject the sublot; (*c*) If d_1 exceeds c_1 but does not exceed c_2, select a second sample of the size indicated in Table I and determine in this second sample the number of articles, d_2, which contain major defects. If $d_1 + d_2$ does not exceed c_2, pass the sublot; if $d_1 + d_2$ exceeds c_2, reject the sublot.

For Minor Defects.—Carry out above procedure with "minor" substituted everywhere for "major," using same sample wherever feasible.

Disposition of Sublot.—If passed for both major and minor defects by above procedure, accept as conforming; if rejected for either major or minor defects by above procedure, return to contractor.

Notes.—Reject all defective articles observed in any of the above inspections. A.O.Q.L. values in right-hand column are poorest average quality accepted if all rejected lots are inspected one hundred per cent and accepted after removal of all defective articles. Above procedure is satisfactory when process average is equal to or better than acceptable-quality level. If process average is poorer than this, acceptance numbers that correspond with the A.O.Q.L. value which is equal to or next better than the acceptable-quality level should be used.

knowledge on the subject must be brought to bear in setting up the detailed procedure. This is what makes its use a scientific arrangement of inspection—it is a procedure developed by experienced men with all available knowledge at hand to be followed by less-experienced men with relatively limited information at hand.

A FUNDAMENTAL requirement of such detailed procedures is that they be planned so that contractors will be held to their responsibility of maintaining a satisfactory quality in the matériel they produce. Ordnance inspection must aim at inducing and assisting the contractor to control his quality at a satisfactory level. Too often inspection is thought of as a procedure for simply sorting out the bad from the good, but that is the job of the contractor. If Ordnance accepts the responsibility for weeding out defective pieces in admittedly inferior matériel, then the contractor has no incentive for improving his production methods so as to turn out the maximum amount of satisfactory matériel from his raw materials.

Furthermore, if the contractor continually presents unsatisfactory batches of matériel, Ordnance must, in order to reject most of these batches, either inspect prohibitively large samples or use such strict acceptance criteria with nominal size samples that a large number of the satisfactory batches will be rejected along with most of the unsatisfactory batches. This, unfortunately, is a weakness of any sampling inspection procedure, for no sampling procedure will accept everything that is satisfactory and at the same time reject everything that is unsatisfactory. In those many cases where a sampling inspection by Ordnance is the only practical procedure, the object of this inspection must be to induce the contractor to maintain a satisfactory quality level and to assist him in doing it. The success of the inspection procedure depends entirely upon the degree to which this object is accomplished. This is what is meant by the "scientific arrangement of inspection procedures."

There is a story told of the green inspector who, when given a number of tensile test specimens and told to "Go break them," came back after an hour's time and, turning over the broken halves, said, "Here they are, all broken. What shall I do now?" This story illustrates an extreme in the inefficient use of inspection results. Although the story is absurd, it requires only a slight modification to illustrate a very common practice among many inspection personnel. Simply change the story to have the inspector return and say, "I didn't bother to record the results, but they all passed."

There is a definite tendency among inspectors to regard any record keeping as an utter waste of time and effort. Usually, the reason for this is the misconception mentioned before; namely, that inspection is for the sole purpose of sorting out the bad from the good. If this is all that inspection aims to do, its purpose is fulfilled as soon as an article or batch of articles is either accepted or rejected. On the other hand, if inspection is to assure that the contractor maintains a satisfactory quality level; if it is to assist production by indicating trends in quality or ways of possible improvement; or if it is to provide any measure of the relative quality levels being maintained by different manufacturers, then some form of records must be kept. An important part of any quality-control plan is a provision calling for the recording of certain results and the routine summarizing and use of these results. The plan will indicate which results are worth while recording and which are not and also how the results are to be summarized. It must include a more or less routine procedure by which simple arithmetical calculations will get out of the data all the information essential to effective quality control. Finally, the plan must prescribe when action is to be taken as a

Sublot Size		500–799			800–1,299			1,300–3,199			3,200–7,999			8,000–21,999			22,000–109,999			110,000 and over		
First Sample Size		10			15			20			30			40			60			100		
Second Sample Size		140			210			280			420			560			840			1,400		
Acceptable Quality Level (Per cent defective)		Acceptance Numbers			Acceptance Numbers			Acceptance Numbers			Acceptance Numbers			Acceptance Numbers			Acceptance Numbers			Acceptance Numbers		
Major	*Minor*	c_1	c_2	c_e	c_1	c_2	c_e	c_1	c_2	c_e	c_1	c_2	c_e	c_1	c_2	c_e	c_1	c_2	c_e	c_1	c_2	c_e
.010–.020	.....	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	1	0
.021–.030	.010–.020	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	0	1	0	0	2	0
.031–.060	.021–.030	*	*	*	*	*	*	*	*	*	*	*	*	0	1	0	0	2	0	0	3	1
.061–.10	.031–.060	*	*	*	*	*	*	*	*	*	0	1	0	0	2	0	0	2	1	0	4	1
.11–.15	.061–.10	*	*	*	*	*	*	0	1	0	0	2	0	0	3	0	0	3	1	1	5	2
.16–.25	.11–.15	*	*	*	0	1	0	0	2	0	0	3	1	0	4	1	1	5	2	1	7	3
.26–.50	.16–.25	0	2	0	0	2	1	0	3	1	1	4	2	1	7	2	1	8	3	1	13	4
.51–1.0	.26–.50	0	3	1	1	4	2	1	6	2	1	9	3	1	11	4	2	13	5	2	23	7
1.1–2.0	.51–1.0	1	4	2	1	5	3	1	8	3	2	13	5	2	16	6	3	25	8	4	40	14
2.1–3.0	1.1–2.0	1	5	3	1	8	4	2	11	5	2	18	7	3	24	9	4	35	12	†	†	†
3.1–4.0	2.1–3.0	1	9	3	2	11	5	2	16	6	3	23	9	3	32	11	5	47	16	†	†	†
4.1–5.0	3.1–4.0	1	10	4	2	14	6	3	19	8	3	28	11	4	37	14	†	†	†	†	†	†
.....	4.1–5.0	2	12	5	3	17	7	4	23	10	4	33	14	5	44	18	†	†	†	†	†	†

*Table not applicable in this region. †Use sample size in first columns to left in which acceptance numbers are shown for acceptable-quality level involved.

TABLE II. REDUCED LOT-BY-LOT ACCEPTANCE INSPECTION

Conditions under Which Reduced Inspection May Be Started.—(1) Production must have been continuous during the immediately preceding 2-week period, and inspection under Table I must have been in operation throughout that time; (2) The last twenty sublots inspected must have come from continuous production and must have been accepted as conforming under Table I; (3) The per cent defective (major) computed from the combined first samples from these twenty sublots and all other sublots inspected during the last 2-week period must have been less than the lower boundary of the acceptable-quality range being used for majors (left-hand column of Table I); (4) Same as paragraph 3 with "minor" substituted for "major."

Procedure under Reduced Inspection.—(5) Select first sample, pass sublot, reject sublot, select second sample, etc., as in procedure for Table I, but using sample sizes and acceptance numbers of Table II. (6) In addition to action on individual sublots under foregoing paragraph 5, the first five such sublots inspected must be considered as a group, the second five as a group, etc. (*a*) As the second, third, etc., sublot in each group is inspected, cumulate the number of major defectives (articles which contain major defects) in first samples from that group, and also the number of minor defectives. (*b*) If at any time during the inspection of successive sublots in a group the cumulated number of major defectives, d_e, in the first samples so far inspected exceeds the c_e indicated in Table II, select second sample of size n_2 from the current sublot and determine the number of major defectives, d_2, in this second sample. If $d_1 + d_2$ for the current sublot exceeds c_2, reject that sublot (d_1 is number of major defectives in first sample from current sublot). (*c*) Same as foregoing paragraph (*b*) with "minor" substituted for "major." (*d*) Whenever a second sample is inspected from any sublot (for either majors or minors), the next sublot is to become the first in a new group of five successive sublots.

Conditions under Which Normal Inspection (Table I) Must Be Resumed.—(7) If either (*a*) a sublot is rejected under paragraphs 5, 6*b*, or 6*c*, or (*b*) $d_e + d_2$ determined under either paragraph 6*b* or paragraph 6*c* exceeds the c_2 indicated in Table II, all succeeding sublots must be inspected by Table I until the conditions of paragraphs 1, 2, 3, and 4 are again met.

result of these summaries and just what the nature of that action is to be. This is what is meant by "efficient use of inspection results."

THE two phases of quality control, scientific arrangement of inspection procedures and efficient use of inspection results, do not operate independently. The arrangement of inspection depends upon what the results of inspection have been and the use of results depends upon the inspection procedure. For this reason a quality-control plan of inspection is a fluid plan; it changes as quality changes. For example, if the quality of matériel produced at one facility is consistently maintained at an acceptable-quality level, the amount of Ordnance inspection is reduced; on the other hand, if quality becomes consistently bad, the amount of inspection is increased, and the acceptance criteria are made more strict in order to induce the contractor to improve his production process.

This is one of the fundamental characteristics of a quality-control plan; namely, that use is made of inspection results not only to accept or reject individual units of production but also to indicate when the inspection procedure being used becomes either excessive in amount or unsafe to use. This, of course, is no new concept; it is just what all experienced inspectors learn to accomplish to a degree by use of good judgment, experience, and rule of thumb; it is what makes their inspection an art. The only difference is that a quality-control plan sets down a simple but definite procedure for attaining the same end more precisely—a procedure that can be applied uniformly to the same matériel by different Ordnance districts throughout the country.

An example of the application of the above principles is the use of Standard Sampling Inspection Tables I and II which have been issued by the Industrial Division, Office of the Chief of Ordnance. These tables and accompanying instructions provide a definite procedure for deciding the acceptability of any matériel which consists of individual articles of a single design produced in quantity and adaptable to inspection for dimensions, finishes, and other characteristics on a go-no-go basis. The tables give sample sizes and acceptance criteria for such matériel produced continually at one facility and presented to Ordnance for acceptance in lots or sublots, each containing 500 or more articles. The tables and attached instructions form the basis for inspection procedures now being used for acceptance in approximately 1,000 facilities producing approximately 200 different ordnance items.

Lieut. R. J. Saunders, in an article on "Standarized Inspection" published in the March-April 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 137, p. 290), has described in detail the use of a somewhat restricted form of Standard Sampling Inspection Table I. The procedure as described in that article has been applied by the Ammunition Branch, O.C.O., to establish a uniform inspection procedure throughout the country. The procedure is essentially a "scientific arrangement of inspection," and represents the first step which is always necessary in the application of quality-control principles. Tables I and II mentioned above add to this an "efficient use of inspection results."

TABLE I (page 118) is essentially a chart which indicates, first, what sample size is to be inspected from each batch or sublot of submitted matériel and, secondly, how many defective articles are to be allowed in that sample before the

sublot is to be rejected. The sample sizes are determined by the sublot size; *i.e.*, the number of articles in the batch being inspected. All the inspector needs to know is the approximate number of articles in the sublot which he is inspecting, and the table tells him immediately how many articles to select for inspection.

The acceptance numbers—how many defective articles are to be allowed in the sample—are determined by three factors: (1) the sample size, (2) the class of the defects in question ("major" or "minor"), and (3) the "acceptable-quality level" for that particular class of defects. To enable him to use the table, the inspector is provided with a standard classification of defects along with an adopted acceptable-quality level for major defects and another such level for minor defects. With these furnished him, he can immediately select from the table both sample sizes and acceptance numbers.

This use of Table I, which is its normal use, represents a "scientific arrangement of inspection," because it is a detailed procedure based upon the judgment of experienced engineers and inspectors and upon a careful study of research and production data. For example, the classification of defects and the adoption of acceptable-quality levels are accomplished by representatives from the matériel operating branches of the Office, Chief of Ordnance, the Ordnance district offices, and the key inspector of the industry integrating committee concerned with the matériel in question. Their decisions are based upon a study of past inspection results and reports from agencies using the matériel. Furthermore, the sample sizes and acceptance numbers of Table I are based upon both statistical considerations and years of experience in the use of such tables.

The table calls for a double sampling procedure (use of a second sample in doubtful cases), since this is more efficient than single-sampling procedures in discriminating between acceptable and unacceptable sublots and because it has been found to possess important psychological advantages. The acceptance numbers were arrived at from a consideration of the number of defectives which can be expected to occur in samples of the given size selected from sublots of matériel whose quality is exactly equal to the acceptable-quality level. They were selected so that at least ninety-five per cent of such sublots would be accepted. This is an essential feature of the quality-control concept; namely, that attention is focused not on the per cent defective which can be allowed in a sample but rather on the per cent defective which the contractor can be allowed to present continually for acceptance.

It is only through a consideration of these statistical factors that one can select sample sizes and acceptance numbers which will operate fairly in assuring one desired quality at many different plants throughout the country.

This normal use of Table I is satisfactory and adequate only when the process average, that is, the average quality of all presented sublots, is equal to or better than the acceptable-quality level. It is therefore necessary to record the results of inspection and to summarize them periodically in order to obtain the process average for each period. If the process average for any period is equal to or better than the acceptable-quality level, then the continued use of Table I in the normal fashion is satisfactory even though several sublots have been rejected during that time.

On the other hand, if a process average is worse than the acceptable-quality level, it means that the contractor is usually presenting unsatisfactory matériel to Ordnance and that some of the sublots which are being accepted by the current sampling plan should be rejected. The only satisfactory solution to this situation is for the contractor to improve his process (either production or inspection), and this he must be called upon to do. In the meantime, however, some acceptance procedure must be used, and Table I affords such a procedure through use of a special column headed "A.O.Q.L." The letters "A.O.Q.L." stand for "Average Outgoing Quality Limit" and represent the worst average quality of accepted matériel if every rejected sublot is accepted after being given a one hundred per cent inspection and all defective articles removed.

The table states that if a process average is worse than the acceptable-quality level, acceptance numbers are to be selected by reference to the A.O.Q.L. column instead of the acceptable-quality-level column as is done normally. This use of Table I will always require smaller acceptance numbers than are required in its normal use and will result in two things. First, there will be very frequent rejections of sublots which should induce the contractor to do something toward improving his product. Secondly, if every rejected lot is given a one hundred per cent inspection and completely cleared of defects, the average quality of all accepted matériel will be equal to or better than the acceptable-quality level. Where such one hundred per cent inspection is not practicable, an improvement of process by the contractor is all the more urgent, because even with this stricter inspection plan the quality of accepted matériel may be much worse than the acceptable-quality level.

EVERY one who has talked very much to veteran inspectors has heard one or more of them say something like this: "Now, over at Company A I don't have to worry about the quality we are getting. I go over there and check on the inspection every now and then, but that company doesn't turn out anything except good stuff. Where I have my worries and where I spend most of my time is over at Company Z." Standard Sampling Inspection Table II (page 119) has been provided to enable Ordnance to profit by situations such as that at Company A while it concentrates its attention in other places such as Company Z. This table is similar to Table I except that the first sample sizes in Table II are only one-fifth as large as in Table I for corresponding sublot sizes, and the acceptance numbers are different in order to compensate for this reduction in sample size.

In order to determine at which facilities the reduced inspection of Table II is justified, the results of lot-by-lot inspection under Table I are summarized continually at each facility. If this summary indicates that the quality of presented sublots is consistently better than the acceptable-quality level for a period of at least two weeks, inspection under Table II can be started and is continued until inspection results indicate a deterioration in quality. A check on the continuance of satisfactory quality is obtained by considering both the results from individual sublots and the combined results from each group of five successive sublots. If these results indicate a lowering of quality, inspection under Table I is resumed. Here is an example of how inspection results are used to indicate that the amount of inspection being performed is excessive and also how the results of a reduced inspection are used to check on whether the matériel being produced day after day continues to be consistently satisfactory.

New Ordnance Matériel

Field Artillery Journal

The barrel and carriage of the new 240-mm. howitzer, shown above, travel in separate loads accompanied by a mobile crane. On reaching position, crane digs pits for spades with clamshell bucket, then sets barrel in place on carriage. The motor carriage M12, below, mounting the 155-mm. gun, is the latest addition to the Army's line of self-propelled artillery.

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JULY-AUGUST, 1943

Month by Month

Readjustments in Munitions Manufacture.—With the exception of certain special programs, some special machinery, and further expansion of raw-materials production, the United States at last has the machine tools and the capital equipment it needs to build production to crush the Axis. For the first time in its history the nation now has a physical plant adequate to make the maximum use of its resources in men, skills, and materials.

Reaching of this significant milestone in the war program and in the nation's industrial development was signalized by action taken by the full board of the War Production Board. The action—designed to throw maximum strength into production of goods for the fighting fronts—called for two steps. The first step involves a reëxamination of all previously approved projects for construction of new manufacturing plants and machinery to determine whether the need for them cannot be eliminated by a greater use of present structures, plant capacities, machine tools, and equipment. The second step calls for no purchase of new machine tools, machinery or equipment, or erection of buildings, until it has been conclusively proved that the work cannot be done by existing facilities.

The effects of the move will be far-reaching. Some new facilities now being built will be stopped; some facilities which are now in place producing direct or indirect military goods will be curtailed as shifts are made from one type of production to another. These shutdowns and curtailments represent a gain to the war effort—they free skilled craftsmen who are urgently needed in war plants, and they free for direct war production machinery and equipment which are needed with equal urgency. All in all, they make it possible to continue the rising rate of over-all war production which must be continued if the year's program is to be met. (See remarks of Lieut. Gen. Brehon B. Somervell, Commanding General, Army Service Forces, on p. 131 of this issue.)

All this, of course, means that the nation has increased its manufacturing capacity enormously. It has increased it so enormously that maintenance of facility expansion at the 1942 level—which at times took nearly three million men from the country's labor force—is obviously no longer called for. Likewise, when the production of all-important items such as ships and guns is governed by the supply of steel, it is no longer wise to divert from twenty to twenty-four per cent of the nation's steel output to the construction field, as was the case at one time last year.

In many parts of the war program, the volume of war matériel which can be produced is limited by the supply of materials available rather than by lack of manufacturing capacity. Any reduction which can be made in new construction thus will release for direct munitions production substantial quantities of steel and other metals which otherwise would go into buildings or into machinery. In the metal-working industries as a whole, full 2-shift operation of all machines would more than use up all the materials presently available.

Thus there is now being undertaken, within the war program, a conversion job not unlike the conversion that accompanied industry's original change-over from civilian to military production. Past experience in plant conversion and machine-tool transfers indicates that many plant facilities originally planned for the production of curtailed items can be readily converted to the production of items for which demands are more urgent.

Two new tests will be applied by regional offices of the War Production Board before approval is given to priority ratings assigned by officers of the Army, Navy, or other Government agency for delivery of machine tools and capital equipment. These are (1) that the item requested must be required urgently, and (2) that no suitable second-hand equipment or subcontracting facilities are available.

Preventive Maintenance.—The vital need of preventive maintenance of Army motor vehicles in the field was re-emphasized recently by the following statement of Gen. H. H. Arnold, Commanding General of the Army Air Forces, addressed to the men and women of the Army of the United States.

> Americans are fighting a war on wings and wheels in every part of the world. To keep our global Army at peak performance, we need the men and machines of motor transport as never before. Truck wheels are rolling up the world's last frontiers.
>
> In 1918, motor transport was crude, but its only maintenance problem was the mud of French battlefields. Today, mechanized giants must blast new Overland Trails through jungles, cross high mountain ranges,

and haul food, bombs, and fuel across blistering deserts in order that our fighters can attack the enemy by land and air.

The details of preventive maintenance have been prescribed to you. Any additional information you may need is available for the asking. For success in every theater, we must depend upon trucks and must have responsible men to keep them rolling. That is *your* stake in victory.

War Production.—While new high points were reached in the production of munitions during March, the rate of production for the first quarter of 1943 lagged behind schedule. The output of munitions for the first quarter was only eighteen per cent of the output scheduled for the year, indicating that the average production for each succeeding quarter must be brought up to twenty-seven per cent to meet schedules in accordance with military plans.

In spite of this production lag, new records were registered in the construction of airplanes and ships. Airplane output reached a high of 6,200 planes, and the construction of both naval and merchant ships, measured by the value of work done in shipyards, was the greatest on record. The production of ground ordnance increased seven per cent during March, and the manufacture of miscellaneous munitions was stepped up twelve per cent. Although there are indications that war production during the next several months will show substantial gains, the very great advances made in the last year cannot be sustained many months longer, according to WPB.

"One of the factors we must face is that the amount of steel available for war production, although enormous, has its limits," WPB Chairman Nelson said. "We are nearing top capacity in steel production. Our allocation system has cut down steel going into civilian production close to a minimum. This means that war production is getting as much steel as it can get. Hence, to attain our goals, it will be necessary to use in place of steel less scarce metals, plastics, and wood."

Although the output of aircraft and related ordnance and equipment increased eleven per cent in the month, part of the gain was due to the additional days in March. The daily average of airplane acceptances increased three per cent on a value basis. Deliveries during the first quarter of 1943 exceeded those of the last quarter of 1942 by about one-sixth.

Heavy bomber production passed the 500-a-month mark for the first time. The number of medium bombers produced also increased rapidly, and acceptances of all types of fighters rose. One-engined Army and Navy fighters showed especial progress. Marked gains were made also in production of transport planes. Secretary of Navy Knox told a press conference that during March the Navy received 1,400 airplanes of which about half were combat ships and half trainers. In April, he said, for the first time "the number of combat planes delivered was in four figures."

Production of ground ordnance, including signal equipment, rose seven per cent in March. Combat vehicles showed a gain of 13 per cent, almost 3,000 tanks having been delivered. In addition, a large number of self-propelled guns mounted on tank chassis were produced.

March production of guns and their equipment was slightly greater than in the previous month, but during the quarter a marked gain was made in the output of important self-propelled artillery and antiaircraft fire-control equipment, as compared with the previous quarter. Throughout the range of ground ordnance there is a shift toward heavier types of equipment.

In the first quarter of 1943, almost 18,000 artillery pieces, including more than 7,000 antiaircraft guns and more than 8,000 antitank guns were produced. Factories also turned out about 235,000 machine guns and more than 1,000,000 rifles and submachine guns.

Report on Lend-Lease.—In his general discussion of the Lend-Lease program during the first twenty-six months of its life, President Roosevelt, reporting to Congress on May 25th, related in some detail the meaning of the allied victory in North Africa and the part which Lend-Lease played in it.

"In Africa we have dealt a blow which is sorely felt in Berlin and Rome and Tokyo," he said, "and we have brought hope to millions still to be liberated. Liberation of Africa is a forerunner of the future."

The President's report of total aid through April, amounting to $11,102,000,000, showed that $9,214,000,000 represented goods transferred to our allies and $1,888,000,000 represented services supplied. Munitions, the President said, amounted to 46 per cent of total Lend-Lease aid. Shipments in March, he stated, reached an all-time high mark of $712,000,000.

The accompanying table gives a theater-by-theater account of Lend-Lease aid in munitions and other exports from March 1941 through March 31, 1943 (in millions of dollars).

Article	*United Kingdom*	*U.S.S.R.*	*Africa and Middle East*	*China, India, Australia, N.Z.*	*Other*	*Total*
MUNITIONS						
Ordnance	148	60	93	78	36	415
Ammunition	265	220	186	145	42	858
Aircraft	199	327	135	139	87	887
Tanks	104	180	133	117	19	553
Motor vehicles	94	229	148	113	23	607
Watercraft	71	25	15	7	14	132
Total	881	1,041	710	599	221	3,452
INDUSTRIAL ITEMS						
Machinery	191	122	61	50	6	430
Metals	334	235	94	104	12	779
Petroleum products	261	11	35	43	5	355
Other	185	97	56	42	27	407
Total	971	465	246	239	50	1,971
AGRICULTURAL PRODUCTS						
Foodstuffs	1,033	283	40	24	19	1,399
Other	231	33	4	13	2	283
Total	1,264	316	44	37	21	1,682
Total exports*..	3,116	1,822	1,000	875	292	7,105

**Totals do not include the value of certain Lend-Lease planes which were flight-delivered and ships which were lend-leased and sailed to their destinations under their power. The value of these is estimated at about $700,000,000.*

A full flow of supplies to China probably awaits the reopening of the Burma Road, although the report said that "new land routes are being developed to increase Lend-Lease shipments to China."

A new development since the previous report was the fact that shipments of munitions to Russia, which did not begin until November 1941, now exceeded those to the United Kingdom, although Lend-Lease exports to the British began six months earlier. The munitions shipments to Russia totaled $1,041,000,000 by the end of March, as compared with a total of $881,000,000 to the United Kingdom.

Preparedness Tomorrow

An Editorial

THERE is an old proverb that "history always repeats." It is a human tendency to assume that proverbs embody the wisdom of the ages and therefore to accept them unthinkingly. Many things do, indeed, repeat themselves in a somewhat cyclic order. Certainly the farmer may safely assume that the seasons will continue to alternate and may plant his seed in the security that, in due time, the harvest will follow. But the effect of the annual cycle is not constant from year to year. The farmer may encounter a period of good crop years, followed by a sequence of bad. A different sort of cycle has intervened.

But there is another changing aspect of human events which, in the long run, is more difficult of comprehension but also more important to be comprehended if we are to exercise an orderly control of our national and international relations. This is the effect of things which do not repeat but, having happened, exercise their influence ever after or until, perhaps, they are superseded by other newer and more dominant factors. These so-called secular factors may be illustrated by the influence of the introduction of gunpowder into warfare. Before its use, the feudal system reigned in all its glory. The lord of the manor could retreat with his retainers into his thick-walled castle and there might hold out almost indefinitely against his enemy.

With the development of gunpowder and cannon the situation was radically changed. A lord could be dislodged from his castle by another lord having cannon at his command for the purpose. But the new weapon was comparatively expensive. Economics came into play. The richer and therefore more powerful lords could prevail over the poorer ones and hence increase their wealth and their ability to provide themselves with the new weapons. Gradually, the most powerful lords became kings and emperors over hosts of lesser lords. Manors were welded into larger units and nations and nationalism began to develop. A technological development had resulted in political changes of the most revolutionary character.

The above is but a very rough outline of the influence which a new development may have upon world organization. Many other secular factors, of course, were at work at the same time, each of which also played its part in the historical panorama. The change was slow *but continuously in one direction*. History, in that respect, has never repeated itself.

Actually we are always confronted by a continual adjustment and readjustment of our whole world political and economic setup in the attempt to assimilate newly developed factors and to adjust ourselves to the new conditions of equilibrium thereby created. But conditions of equilibrium are never reached. Long before today's conditions are met, new factors have been developed and equilibrium has moved on. The phenomena of a static world are not among the problems which confront us.

A problem of vital concern which does confront us, however, is that of insuring that as new developments come along their implications for the national defense be studied and the necessary steps taken to insure that the United States shall at least not lag behind any possible adversary in its ability to exploit potentialities to the utmost for its protection under emergency conditions. The following editorial from the Baltimore *Sun* of May 20, 1943, shows that there is an increasing appreciation of the importance of this necessity.

> There is a growing awareness that in the midst of war we should prepare for peace. C. F. Kettering, one of the country's most distinguished figures in engineering research and invention, has just given us a helpful reminder that long before this war comes to an end it is well to think of planning for—or rather against—a next war. His suggestion is that, apart from the mere operating requirements of Army and Navy, a billion dollars a year be set aside for the services to spend on the improvement of their present weapons and the development of new ones.
>
> It is not too early to think of such a plan. America has thought of such things before, but in peacetime, and the thoughts have all but died in infancy, kept feebly alive only by a handful of the determined professionals of the Army and Navy and a very few civilians.
>
> On May 21, 1940, a year and a half before Pearl Harbor, *The Sun* printed a summary of what Congress had actually allowed the Army and Navy to spend on new and modernized equipment during the preceding decade. It amounted to a yearly average of $142,500,000 for the Navy and $40,000,000 for the Army. In 1934, when Hitler was beginning to build up his immense army, the United States was reducing its own Army outlay and allowing only 3.2 per cent of its War Department budget for the purchase of new weapons. It suggests why we were, in 1941, so ill prepared for war against the two chief warmakers of the world.
>
> Mr. Kettering's warning comes only a week after another warning, also given in Baltimore, by Rear Adm. W. H. P. Blandy, the Navy's Chief of Ordnance. The Admiral reminded his hearers that research must precede manufacture and that hence it is never too early to begin research for the production of new weapons with which to defend the nation, whether they are ever actually employed or not. "If our efforts help to make war obsolete, so much the better," he remarked, but with a reminder that it is better to be safe than sorry. (Editor's Note.—Admiral Blandy is the author of an article on naval armament on page 81 of this issue.)
>
> Against our expenditures for defense during the 'thirties, certainly $1,000,000,000 a year looks very large. Against what war has cost us since 1941—and largely because we had not spent more intelligently before it was compulsory—$1,000,000,000 is very small. If, through such an expenditure, war should be made less likely, as Mr. Kettering suggests, it would be one of the cheapest expenditures a nation ever made.

Such thinking bodes well for American preparedness in the days to come. But whether the billion dollars materializes or not, the Army Ordnance Association will continue in the future to foster industrial readiness against war as our strongest guaranty of peace with the same spirit that it has done so for the past twenty-three years.

Association Affairs

Los Angeles Post

THE Los Angeles Post of the Army Ordnance Association and the Los Angeles Chamber of Commerce on April 21st jointly sponsored a dinner in honor of Maj. Gen. Levin H. Campbell, Jr., the Chief of Ordnance. The Fiesta Room of the Ambassador Hotel provided accommodations for only 525 of the many who wished to honor General Campbell. The high point of the evening was an address by the General in which he complimented the Southern California area on the fine work being done for the Ordnance Department.

Frank Doherty, president of the Los Angeles Chamber of Commerce, formally welcomed General Campbell and turned the meeting over to the toastmaster, K. T. Norris, a director of the Los Angeles Post of the Association and president of the Norris Stamping and Manufacturing Company. Short welcoming speeches were also made by Fletcher Bowron, Mayor of Los Angeles, and A. H. Campion, Los Angeles County Manager.

The following military and naval personnel were seated at the speakers' table and were introduced to those present: Brig. Gen. S. E. Reimel, Tank-Automotive Center; Col. C. Wingate Reed, Office of the Chief of Ordnance; Maj. T. J. Moore, Jr., Office of the Chief of Ordnance; Rear Adm. J. R. Defrees, Office of the Inspector of Naval Materials, Los Angeles Area; Brig. Gen. Bethel W. Simpson, commanding general, Ordnance Training Center, Camp Santa Anita, Calif.; Col. K. B. Harmon, chief, San Francisco Ordnance District; Lieut. Col. Samuel Metzger, Western Procurement District, Army Air Forces, Los Angeles; Maj. Ralph Ansbach, Ordnance officer, Los Angeles Port of Embarkation; Maj. C. W. Clark, commanding officer, Los Angeles Ordnance Region.

General Campbell, in addressing the meeting, spoke in part as follows:

"Gathered here tonight are representatives of three of your leading civic and industrial organizations. In the Army Ordnance Association, our country has a valuable adjunct to its national defense. Founded twenty-four years ago for the sole purpose of fostering 'industrial preparedness' as one of our nation's strongest guaranties of peace, the Association throughout the country has led the forces of industry as a part of our national military strength. The Association's national membership of more than 15,000 American citizens is proof of its strength and its purpose. As Chief of Ordnance of the Army, I am grateful for the assistance the Association has given the Ordnance Department at all times.

"It was a most natural thing that we should look to Southern California as a training center for our Ordnance soldiers. Not far away at Santa Anita we have in operation one of our largest training schools. Here our officers and men are taught under ideal conditions the responsibilities and the techniques of keeping our guns shooting and our tanks rolling. This school is a West Coast version of our great training center at the Aberdeen Proving Ground in Maryland. At Santa Anita, the young men who are now entering the Ordnance Department in such great numbers are taught how to serve our ordnance equipment so that they may accompany that equipment to the front lines of battle and make certain that it is in operating condition at all times. That is a most important function of the Ordnance Department. The men who are being trained here are part of the great Army Service Forces and their handiwork is producing good results wherever American soldiers are facing the enemy.

"Also, not far away from here you have an Army training establishment which simulates desert conditions. There our ordnance is tested in maneuvers at a place which most closely resembles the heat, the sand, and the distances of North Africa. Those of you who may not be familiar with the extent to which we must go in developing our ordnance will be interested to learn that our fighting material is tested under the most severe conditions. In looking for a counterpart of the Sahara, we come to Indio and test our guns, ammunition, and tanks at temperatures resembling those of the tropics. At the other extreme, we have a winter proving ground in Canada, where we test equipment at temperatures as low as forty degrees below zero.

"Whether it be in the testing of equipment or in the training of men to maintain that equipment in the field, it is the purpose of the Ordnance Department to give our Army the best of service through good equipment and trained men.

"The Industry-Ordnance team consists of industry on the one hand, and the Ordnance Department of the Army on the other hand. When I say industry, I mean every segment of it, the worker and management, little business, medium-sized business, and big business—all have joined in the armament-production effort to an extent which surpasses our hopes and plans. Especially is this true of small business. May I cite just one instance among many to show you what an important part the small business man has in the production of armament for the Ordnance Department. In one region of our country, the Philadelphia Ordnance District, as an example, the total number of Ordnance prime contractors at a given recent date was 1,005, resulting in 7,060 subcontractors. Of the 1,005 prime contractors, 295 employed 500 or more workers; 260 employed between 100 and 500 workers; 450 employed less than 100 workers. Of the 7,060 subcontractors, 1,600 employed 500 or more workers; 1,960 employed between 100 and 500 workers, and 3,500 employed less than 100 workers.

"Confidence is necessary in every great national emergency. I want you to have confidence in the armament of our American forces. I want you to have confidence in the kind of training our boys are given for the maintenance of our fighting equipment in the field. I want you to have confidence in the work that is being done by the Industry-Ordnance team with particular emphasis on employee, as well as employer, and with especial emphasis on the small business man as well as on the large one."

Milwaukee Post

MAJ. GEN. RUSSELL L. MAXWELL, who commanded the U. S. forces in the Middle East until last February, was the guest of honor and principal speaker at a dinner meeting of the Milwaukee Post of the Association held in the Crystal Ballroom of the Schroeder Hotel in Milwaukee on May 3rd. General Maxwell has long been an active member of the Association and was editor of ARMY ORDNANCE during 1925-1926. At present he is commanding general of Camp Ellis, Ill., a new type of organization which will train men in supply and maintenance on the basis of experiences in the Middle East.

Earlier in the day, a private luncheon was held for General Maxwell at the Milwaukee Club, followed by a tour of inspection through the plant of the Bucyrus-Erie Company, which is engaged in war production. During this tour, General Maxwell made several informal talks to groups of employees.

Approximately 500 members and guests attended the dinner in the evening. The toastmaster, Col. W. W. Coleman, president of the Milwaukee Post and chairman of the board of the Bucyrus-Erie Company, introduced Brig. Gen. R. H. Somers, U. S. Army, Ret., executive secretary of the Association, who spoke briefly about the work of the national organization, and Victor W. Bone, of Lincoln, England, who told of the industrial achievements of British management and labor after Dunkerque.

General Maxwell was the principal speaker of the evening. In sketching his journey to Africa in November 1941, he told of visiting Pearl Harbor, Midway, Wake, Guam, Manila, Singapore, Rangoon, Calcutta, Karachi, Basra—finally arriving at Cairo. His experiences also included a trip to Moscow with

Prime Minister Churchill, a visit with Field Marshal Smuts in South Africa, and a 3½-day visit with Emperor Haile Selassie in Ethiopia. Speaking of his work in the Middle East, General Maxwell said:

"Upon arriving in Cairo we set up a headquarters and started to work on our principal task which was to provide maintenance installations for the British forces operating in that area. Our installations were to supplement those already there and we followed the policy of never undertaking a task unless the task was necessary and unless we were convinced that the British forces could not perform this task with the means at their disposal. We found this policy a wise one because it helped to eliminate competition, and, as you know only too well, where you have competition you are bound to have some friction. We worked together very closely with our British colleagues and were proud to do so. They in turn showed great appreciation for our efforts and for the materials sent to them from the United States.

"Our activities were centered in five areas: in Egypt in the center of the Middle East, in Eritrea to the south, on the Persian Gulf to the east, in the Levant area to the north, and in the Libyan Desert to the west. I want to give you a brief outline of the type of tasks which we were to perform. These tasks at times seemed insurmountable. In addition to conditions of extreme climate and those extremely detrimental to health, we were also faced with the very real problem of tremendous distances and lack of adequate communications between these areas. For example, our base in Ethiopia was as far from Suez, the principal port for the Delta area, as Chicago is from New Orleans. Roads and railroads just didn't exist, so it was necessary to resort to air and sea transportation. In Eritrea, the principal installations included an air base, an arsenal, which was made up of a number of small manufacturing shops, a naval repair base. . . .

"In the Persian Gulf we were responsible for expediting the flow of American-made materials to the Russians. To do this it was necessary to build roads, repair and build railroads, build airfields, and repair and operate ports and port facilities. In the Levant and Delta areas we constructed bases at which British officers and men could be trained in the operation and maintenance of American equipment and where battle casualties of all types of American equipment could be rehabilitated.

"After El Alamein, we established Service Command headquarters in Bengasi and immediately set to work to put in airfields, establish roads, repair the railroad which extends as far as Tobruk, and to make the harbors along the coast useful for ships coming up from Alexandria and Suez to bring supplies to the advancing Eighth Army. In this connection it is interesting to note that our heavy bombers had caused much of the destruction which prevailed in the harbor areas along the coast, and as soon as Rommel started back across the desert it was American-made machinery and equipment of all types that had to repair them. Both jobs were done well.

"These tasks, which I have just described, taxed American equipment and American methods to the limit. Our ability was also taxed to plan for those things needed to accomplish the tasks. . . . Certain of the principles which were developed in peacetime were put into practice and their reality realized under field conditions. We know, for example, that merely receiving new equipment cannot bring success. As a result, we put into practice this principle: the better the training is on the use of equipment, the fewer the shops needed to repair equipment and the fewer items of new material required.

"Another principle which was put into practice and which I feel would be of real interest to you, the producers of the materials used on the battlefields of the world today, is that the better the equipment, the less time that equipment must spend in the shops. This last principle can only be put into effect when you receive the very best of equipment. From tanks to revolvers on the front line and from all types of heavy maintenance equipment down to the smallest wrench in the base shops, you realize the great dependence we have on machines and equipment today. During the battle of the Western Desert, our railhead extended only as far as Tobruk. As a result, battle casualties had to be brought back by road when major repairs were needed, and that road was under constant bombardment.

"Heavy machinery could be repaired and parts supplied much more readily in the rear areas than could those machines in the forward areas, but there again you are faced with the problem of having your equipment stand up so that you don't have to wait for more to be sent from the United States. The better you make the equipment, the better job the Army can do in the theaters of operation. The fact that our British colleagues appreciated the excellence of the workmanship which has been put into the American equipment was indicated to me in a way which left no doubt, whatsoever, in my mind. They like it and want more of it, and when they get it they use it well. I can speak from first-hand knowledge of the equipment only in the Middle East theater, but I feel certain that the same situation applies in the other theaters."

NEW YORK UNIVERSITY POST

THE twenty-second Post of the Army Ordnance Association was chartered in April with the organization of a local chapter at New York University, New York City. Aided by Maj. Carlos deZafra, Ord. Res., assistant professor of engineering, as faculty adviser, a group of engineering students held organizational meetings and finally formed the new Post and elected officers. Thomas R. Torian, one of the organizers, was chosen to head the new chapter. Other officers are: M. L. Goldstone, vice-president; H. S. Davis, secretary-treasurer; H. W. Sternfeld, Elliot Schick, H. S. Davis, R. F. Borg, and I. Eisen, directors. Mr. Torian is also the author of an article on war gages published in the May issue of the N.Y.U. *Quadrangle*.

The new Post's first evening affair was held on April 15th, when Lieut. Col. Chester Mueller, chief of the Production Service Branch of the New York Ordnance District, was guest of honor at a buffet supper and addressed the members. Colonel Mueller, speaking on "Ordnance in Our Times," outlined the wartime functions of the Ordnance Department and explained the necessary procedure to be followed in obtaining commissions in that branch. The talk was supplemented by motion pictures showing U. S. soldiers in action in a typical island battle and the testing of guns at Aberdeen Proving Ground. An interesting question-and-answer period followed in which both members and guests participated.

While the Association Post is new to the University, ordnance interest is not. During the 1942 summer vacation period, several students of the College of Engineering were employed in various capacities in war production industries. As a result of these contacts with the implements of warfare, an interest developed about a subject heretofore quite foreign to their college curriculum. Upon return in the fall, these students interested others and petitioned the faculty of the College of Engineering for a course in ordnance engineering. The petition met with favorable action and a course in ordnance engineering was introduced in the second semester which began the latter part of January 1943. Although offered as an elective subject for senior engineers, the course was opened also to junior students, who would most likely soon be called to service.

The course is of the basic type intended to acquaint the student with the various kinds of ordnance matériel, the principles underlying their design, problems of manufacture, their tests, uses, care and storage. The subjects include: organization and functions of the Ordnance Department; military explosives, projectiles, fuzes, and ammunition (complete round); types, construction, and uses of cannon; gun mounts—fixed, mechanized, and railway; proving-ground instruments and test procedure; tanks and aircraft offensive and defensive weapons; grenades; pyrotechnics; and, finally, inspection and production control.

Major deZafra has been designated to give the course which is a three-hour-a-week, or 45-hour term course.

PITTSBURGH POST

THE biennial election of officers of the Pittsburgh Post, held by letter ballot, closed on May 12, 1943, and the tabulation of ballots by a committee of tellers showed that the following officers and directors had been elected: H. A. Gidney, president; J. D. Berg and R. C. Downie, vice-presidents; T. H. Eddy, secretary-treasurer; F. B. Bell, W. F. Detwiler, J. K. B. Hare, J. L. Perry, G. M. Sixsmith, A. E. Walker, and the above-mentioned officers, directors.

On April 16th, the Post president appointed a nominating committee, composed of A. W. Robertson, George T. Ladd, and G. A. Blackmore, to select candidates for the offices of the Post in accordance with the Post's by-laws, to serve for a period of two years, from June 1, 1943. All the committee's nominees were elected as mentioned above and will serve until June 1945.

ORDNANCE SCHOLARSHIP AWARDS

SCHOLARSHIP keys awarded by the Association for outstanding ability and leadership in Ordnance R.O.T.C. units have been recently presented as follows:

At the Agricultural and Mechanical College of Texas, the award for senior year was presented to Earle F. McSpadden, Jr., of Teague, Tex., now in the Ordnance Department of the Army. The award for junior year was presented to Dan P. Maley, Jr., of Sulphur Springs, Tex.

At Cornell University, two awards were made in the senior year, the recipients being David J. Coons, of Woodmere, N. Y., and Hugh M. Grey, Jr., of Concord, N. C.

At University of Michigan, the senior award was presented to Philip Sharpe, former vice-president of the U. of M. Post of the Association, now in the Ordnance Department.

At Massachusetts Institute of Technology, the senior award was won by John I. Harsh and the junior award by John F. Hardie. Col. Charles E. Fuller, Ord. Res., made the presentation at the Army Ordnance Association supper held on May 15th.

At Lehigh University, the key for superiority in ordnance scholarship in senior year was awarded to Glenn A. Murray, of Pittsburgh, Pa., and in junior year, to Louis M. Domeratzky, of Washington, D. C.

NEW FORMAT FOR ARMY ORDNANCE

DUE to the paper limitations which have been placed upon publications by WPB, ARMY ORDNANCE has been forced to make several changes in its format rather than decrease the number of pages in each issue. The two principal changes are that the weight of the paper has been reduced considerably and the over-all size of the magazine has been reduced from 9 by 12 inches to 8½ by 11½ inches. The size of the type page has been left unchanged, however, insuring as much reading matter as always. Future changes will be governed by the paper supply, and any curtailment of size or space will be made only when absolutely necessary.

This issue begins a new volume (Vol. XXV). The index for Vol. XXIV, arranged alphabetically by subject and author and with title page for binding, may now be obtained without charge upon request. This index covers subjects from the January-February 1943 issue (Vol. XXIV, No. 136) to the May-June 1943 issue (Vol. XXIV, No. 138) inclusive.

NECROLOGY

EDSEL B. FORD, president and treasurer of the Ford Motor Company, died at his home in Grosse Point Shores near Detroit on May 26th. He was long a member of the Army Ordnance Association and was serving as a director of its Detroit Post.

He was identified with his father in the manufacture of automobiles from the beginning of his active career and in later years took over almost complete management of the vast Ford interests which are now devoted in great part to the manufacture of war products.

Mr. Ford, who was 49 years old at the time of his death, in addition to his wife and daughter is survived by three sons, all of whom are serving in the armed forces—Henry as a lieutenant (j.g.) in the Navy; Benson in the Army Air Forces, and William as a naval air cadet.

Edsel Ford will be missed, not only by the industry which he served so well, but by every exponent of industrial preparedness.

COL. JAMES A. DRAIN, 72, former national commander of the American Legion and an American officer who helped point the way toward tank warfare, died on May 31st at Washington, D. C., after a long illness.

He was a colonel in the first World War and sat with British officers as a member of the first tank commission a quarter of a century ago. He recently had been an assistant to the administrator of the Federal Security Agency.

He was an attorney, but his principal interest was in the armed services, particularly the National Guard, which he served at one time as chairman of its national executive committee. In his National Guard work he was credited with helping draft legislation which in the first World War permitted the Guard to be called out as a part of the Regular Army.

Born in Warren County, Ill., Colonel Drain spent most of his life in Spokane, Wash., where he became adjutant general of the state's National Guard, and in Washington, as national representative of military organizations. He was also the founder of the *American Rifleman*, now the organ of the National Rifle Association.

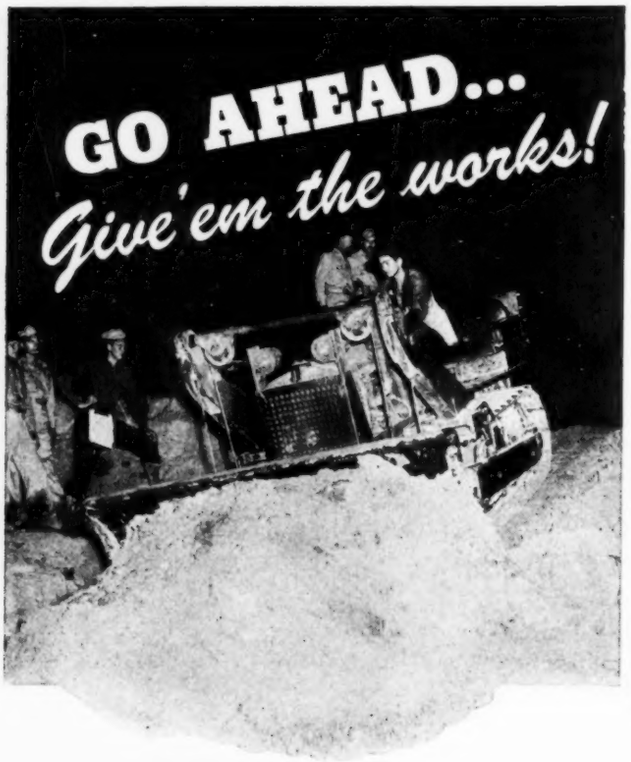
He was original Ordnance officer of the 1st Division in the last World War, and held the Distinguished Service Medal, the French Legion of Honor, and the Cross of Italy for his services.

CAPT. WILLIAM SPARKS, an outstanding industrial and civic leader of Jackson, Mich., died on May 14th, after a long illness, at the age of 70.

He earned a captaincy in the Michigan National Guard several decades ago. Captain Sparks first came to Jackson County with his parents from his birthplace in Burrington, Devonshire, England, in 1879, when he was 6 years old. As a youth he became associated with Phillip and Winthrop Withington in a plant to manufacture buggy accessories.

As the Sparks-Withington Company, with Captain Sparks as head, the firm thrived, becoming one of the largest manufacturers of auto fans and horns. Later it developed the Sparton radio and for a time made refrigerators. The plant now is engaged in war production. Captain Sparks retired as head of the firm several months ago because of ill health, and his sons, Harry G. and Clifford M., took over.

NOTICE also has been received of the deaths of the following members of the Association: James C. Alley, New York, N. Y.; Allen C. Badger, Youngstown, Ohio; Richard deWolfe Brixey, New York, N. Y.; John Dangmann, New York, N. Y.; Nelson J. Darling, Beach Bluff, Mass.; James A. Farrell, New York, N. Y.; Benjamin Klein, Philadelphia, Pa.; N. A. Krogman, Saginaw, Mich.; P. G. March, Jr., Cincinnati, Ohio; W. T. Penninman, Wilmington, Del.; W. A. Ratcliffe, South Haven, Mich.; Charles A. Walker, Jr., Washington, D. C.; John C. Wattleworth, Cleveland Heights, Ohio; P. Woolfolk, Talladega, Ala. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.



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Ordnance in Review

The Machine Gun—The Period of Recognition, Part III

Lieut. Col. Calvin Goddard

Of the four machine guns exhibited at the Philadelphia Centennial Exposition, 1876 (see Part I of this series in Army Ordnance, March-April 1943, p. 315), three—the Bailey, Gardner, and Gatling—have already been discussed at some length. The fourth was a piece designed by a Swedish engineer, H. Palmcrantz, and known sometimes under his name, more often under that of a fellow countryman, Thorsten Nordenfeldt, who conducted a banking business in St. Swithin's Lane, London, and financed the Palmcrantz enterprise. Johnson and Haven ("Automatic Arms," New York, 1941, p. 18) give the following brief description of the Palmcrantz-Nordenfeldt gun (Fig. 5):

"From two to six barrels were placed in horizontal alignment and fired in succession or in volleys by moving a lever on the right side of the breech backward and forward. Hoppers above the barrels supplied the ammunition by gravity. The empty shells fell out of openings in the bottom of the action as they were extracted by the backward movement of the hand lever. Several hundred shots per minute could be delivered from this gun. It was very popular throughout Europe during the 'eighties and early 'nineties, especially as a naval fixed-mount gun. . ."

In Farrow's "Military Encyclopædia" (New York, 1885, Vol. II, pp. 420-424) appear descriptions of no less than fourteen types of Nordenfeldt's gun then current. To this article we refer those seeking more information upon details of its construction than is offered in the short excerpt from Johnson and Haven, just quoted. Suffice it to say that mechanically the weapon did not differ radically from the Gardner, a fairly comprehensive description of which appeared in Part I *(loc. cit.)* of this series. We shall, however, undertake to list briefly the basic Nordenfeldt models described by Farrow, if only to show how machine-gun-minded the world had become in the twenty years following the close of the American Civil War. The principal characteristics of the fourteen Nordenfeldt types are listed in the accompanying table (p. 130).

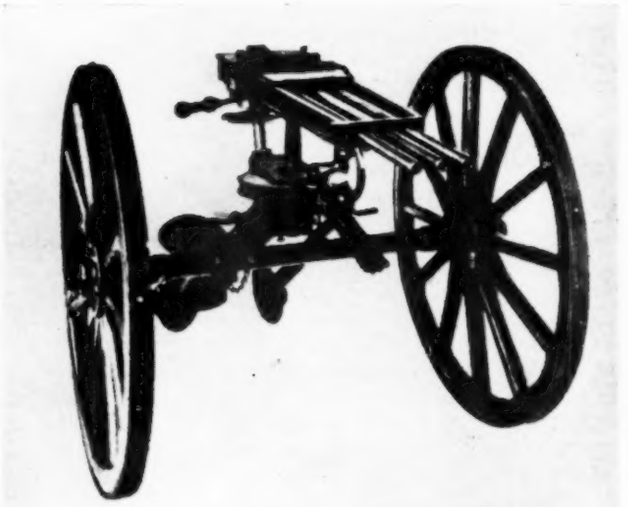

Fig. 5. A Nordenfeldt Machine Gun

Colonel Goddard is chief of the Historical Section, Office of the Chief of Ordnance, and a member of the board of editors and advisers of the Encyclopædia Britannica.

Those who marvel at the *cyclic* rates of fire quoted for certain modern machine guns may well pause for a moment to digest the figures in this table and those which follow. For one of these guns, whether Type 8 or Type 9 is not indicated, in July 1882, at Portsmouth, England, fired 3,000 rounds in 3 minutes, 3 seconds. This constituted, to all intents and purposes, a *sustained* rate of fire of 1,000 rounds a minute for the period involved. The fact that but one hundred of these rounds issued from any

FIG. 6. HOTCHKISS MACHINE-GUN CANNON

given barrel per minute scarcely diminishes the brilliance of the performance, now over sixty years past.

For designers who are today bending their inventive energies toward producing a light machine gun which shall not materially exceed in weight the standard shoulder rifle, the following quotation from Farrow's Encyclopædia (Vol. II, p. 424) with respect to the Nordenfeldt gun, Type 14 in the table, should be of interest:

"This gun is made with a different mechanism from the two patterns above-named *(i.e.,* Types 12 and 13). It weighs 13 pounds, and it fires at the rate of 180 rounds per minute; it has often fired successive spurts of 30 shots each in 8 to 10 seconds. This gun has been made in order to show that a single-barrel machine gun need not be more than four pounds heavier than an ordinary rifle; at the same time, no single-barrel rifle caliber would really be used in war—except, perhaps, as a wall piece—when it is proved that even a 3-barrel can be made light enough to be carried by a man on his shoulder. A general would probably not submit to the expense and inconvenience of a machine-gun equipment and service of men and mules for gun and ammunition, when the efficiency of the gun is entirely dependent on one single rifle barrel."

HAD Farrow been possessed of second sight, he would have left the last sentence unwritten. For the Maxim gun, a piece destined eventually to render obsolete all rifle-caliber machine weapons embodying *more* than a single barrel, had already been invented (1883); indeed, he had accorded it considerable space on page 288 of the same volume in which the above appears. Strangely, he does not mention it among the weapons which he lists under the captions "Battery Guns" and "Machine Guns"—the former being the designation originally attached to this class of arms and employed even as late as 1883. (Maxim's first English patent, dated July 16, 1883—No. 3943—is for an "invention of improvements in machine or battery guns. . .")

Among the weapons listed by Farrow as "Battery Guns" and "Machine Guns" we find under the former title the Gardner, Gatling, Hotchkiss, Lowell, Nordenfeldt, and Taylor; under the latter, the same, less Nordenfeldt and Taylor. Again, in a table in which he presents the results of accuracy trials of cer-

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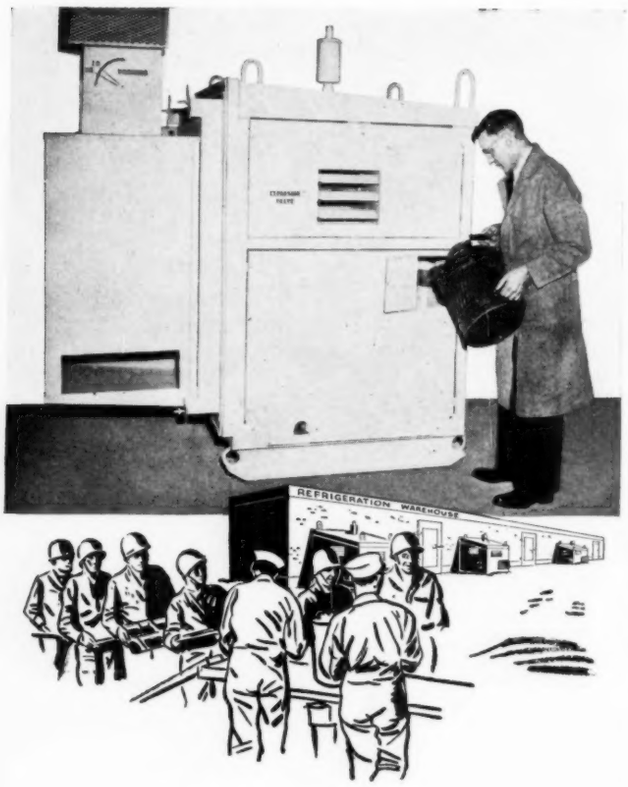

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Ordnance in Review

tain machine guns then current (Vol. II, p. 241) there appears a name not previously recorded—that of the well-known firm of Pratt & Whitney of Hartford, Conn. This led the writer to believe that he was on the track of a machine gun previously unknown to him, until further investigation revealed the fact that Pratt & Whitney were manufacturing the Gardner gun at the time of the trial in question, it being entered under their name rather than that of the inventor. (See "The Pratt & Whitney Improved Gardner Machine Gun" as published by Fowler and Miller, Hartford, Conn., 1885.) In addition to the weapons above named, one foreign piece, the Montigny mitrailleuse, is noted as having contested in the first of the four trials recorded in Farrow's table. Apparently it was not served by experienced gunners for, after a preliminary run of 24 "sighting shots," a 30-barreled specimen of this weapon made exactly no hits out of 100 rounds fired for record at a range of 500 meters!

Of the guns named above, the Hotchkiss, Lowell, and Taylor remain as yet undescribed in these papers. The first of these (Fig. 6) was the earliest modern "machine-gun cannon," no model being designed for the use of ammunition of less than 37-mm.

Type	*No. of Barrels*	*Bore*	*Muzzle Velocity (foot seconds)*	*Wt. (lbs.)*	*Shots per Min.*	*Projectile Wt. (oz.)*
1	2	1¼″	1,600	450	80	22.000
2	2	1¼″	1,500	375	.....	14.125
3	2	1″	2,009	400	.....	9.750
4	4	1″	1,650	...	.....	8.900
5	5	1″	.....	...	.....	.....
6	4	1″	.....	...	.....	.....
7	2	1″	1,500	315	120	.....
8	10	(Various rifle calibers)	1,300 (Avg.)	250	1,200	400–500 Gr. (Avg.)
9	10	*Do*	*Do*	200	1,000	*Do*
10	7	*Do*	*Do*	150	750	*Do*
11	5	*Do*	*Do*	100	600	*Do*
12	3	*Do*	*Do*	55	400	*Do*
13	2	*Do*	*Do*	40	300	*Do*
14	1	*Do*	*Do*	18	180	*Do*

Characteristics of the Basic Nordenfeldt Machine Guns

caliber. Resembling the Gatling in general external appearance, it differed from that weapon in construction and operation. Again we refer the interested reader to Farrow's Encyclopædia (Vol. II, pp. 59-62) for a detailed description. The following, however (p. 59), merits reprinting:

"A peculiar feature of this gun consists in the barrels remaining *still* during the discharge, so that there is no movement of any kind to impede the accuracy of the fire. This stop or lost motion is obtained by the shaping of the driving-worm, which is so constructed that the inclined driving-thread only covers half its circumference, the other half of the thread being straight. The effect of this is that the barrels only revolve during half a revolution of the worm, and stand still during the other half revolution. The combination of the mechanism is so arranged that the loading, firing, and extracting take place during this pause."

Failure to include herein any more comprehensive discussion of the Nordenfeldt and Hotchkiss guns is due to the fact that almost all the fairly numerous volumes available on automatic arms treat rather fully of these, while quantities of additional material upon them are to be found in the military literature of the period, 1880-1900. As a result, the avowed object of the present writer is to devote as much as possible of the space available to him to discussions of the less well known types which flourished briefly during the three decades, 1855-1885.

(*To be continued.*)

From the Record

TOTAL WAR PRODUCTION HAS NOT BEEN REDUCED

IT'S been rumored that the Army is closing hundreds of plants and that widespread unemployment will result—I'm here to spike this rumor. There have been a few temporary stoppages in a few plants. These are not the result of surpluses of military items: they are the result of readjustments due to battle changes. I wish we could standardize tanks, guns, and planes and let them pour endlessly off assembly lines. But this would lose the war. Combat changes military needs. Climate and battle conditions require great variety of fighting tools. We can't predict what the enemy will do—the battle line sets requirements for the assembly line. Last week's tank may be no match for this week's enemy gun.

Our total stock of raw materials is limited—you just can't stretch steel or copper. We have so much and no more. When enemy submarines and stepped-up air warfare required us to build more ships and planes we had to take steel from the Ground Forces. This causes some temporary shutdowns. Out of ninety closed plants, eighty-four have been restored to use. The other six, making explosives and ammunition, are held partially in reserve. Total war production has not been, and will not be, reduced. On the contrary, each month this year we increased production on Ground Forces items alone by $100,000,000. We will continue to step up the program, at this same rate, until at least the end of the year, when we should level off but not decline. Until we do win we must not slow down—we dare not relax.—*Lieut. Gen. Brehon B. Somervell, Commanding General, U. S. Army Service Forces, on March of Time program, National Broadcasting Corporation.*

BRITISH LESSONS FROM TUNISIA

ONE thing which soon became clear in the Tunisian campaign, and which was partly remedied as the campaign continued, was that parts of the (British) First Army's original equipment were outdated and inadequate. When the First Army left England, we were in a fluctuating mood about heavy machine guns. The Germans had many more for each battalion than we had and used them with utmost skill. They made equally skillful use of their many heavy mortars, particularly valuable in hilly country where dropping fire is often the only means of hitting a desired target. We were at a disadvantage in the air until we got Spitfire 9's to supplement our Spitfire 5's.

Our original tanks were Valentines, Crusaders, Grants, and Honeys—all outdated now, though useful for certain limited purposes. By the time we stormed Tunis, we had Churchills for infantry support, and our armored division had Shermans with 75-mm. guns. But we were still operating with armored cars which were no match for the big German 8-wheelers, and in an open fight we had to rely on cunning in maneuvers.

The Churchill tanks were a big success. They proved quite versatile and more reliable mechanically than some tank officers expected, but they had one defect which is still unremedied—they were intended for infantry support, but they were equipped with antitank 6-pounder guns, and the first ones didn't even have high-explosive shells. Their only munition originally was armor-piercing shells, inappropriate for attacking enemy infantry or machine guns. This lack was later remedied, but the Churchills will not realize their full possibilities until fitted with some form of field gun.

The whole trend of tank experience was toward regarding the tank essentially as mobile artillery. In addition to field guns

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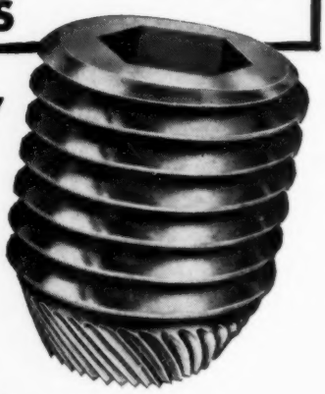

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From the Record

mounted in tanks, both the Germans and Americans had self-propelled guns which did invaluable work. We did not for several months and felt the lack of them. In the final offensive, one of our divisions outran its artillery. On this and other occasions during hill fighting we would have been glad of more mobile artillery than we had.

Another minor but serious weakness in tank work was the lack of really good field glasses. German glasses had bigger magnification and a bigger field than ours, and this was a handicap when fighting in close, broken country where it was important to identify enemy antitank guns instantly.

Their motorcycles are beautiful jobs, superior to ours; and their range finders and sights for 88's are absolutely first class.

In personal kit, such as ground sheets and tents, they appear to have achieved greater lightness without sacrificing quality. I never saw a sign of bad workmanship or inferior materials in any of the captured German equipment.

In one respect, we have had superiority throughout the campaign. This was in artillery and 25-pounder guns. The latter reënforced its claim to consideration as the world's best all-around gun.

We developed considerably the technique, first used in the Western Desert, of sudden, massed firing by perhaps one hundred guns. It has been found a strong deterrent to tanks, which can't trace it—even if it doesn't knock them out. It is apt to destroy their wireless aërials and so cut their communications.

Even the artillery had its weak spot at first, for it didn't have enough antiaircraft guns, but this deficiency was made good later.

Sappers did miracles, and sprang their own little surprise. They did endless road making and endless mine lifting. In many respects, this was a sapper's campaign, and I never heard a word of anything except praise for them. . . .

One final lesson, again not new, was that dive bombing has a nasty moral effect on raw troops, but doesn't seriously worry experienced ones. This reënforces the theory put forward earlier that a soldier's education cannot be completed except by fighting.

One of the great gains of this campaign is that the British First Army, the American II Corps and the French army are now much more formidable fighting machines, more skilled, and morally tougher than they were six months ago.—*E. A. Montague, Manchester Guardian correspondent, in the Baltimore Sun.*

American Supply in Africa

I THINK one outstanding characteristic of this whole Tunisian campaign is that supply at no time has failed. In the very beginning we were a little short on both troops and supplies, but where we have the troops I think I can say that without exception they have been supplied adequately. That goes for medical, food, ammunition—ammunition is the most serious element of supply and the most difficult. They have never been short of ammunition. This last battle taxed the supply facilities very much. I remember talking with General Bradley the afternoon before this operation. Our troops had been rushed up from the south of the Tunisian front into position for this attack. It was the first time that corps had been assembled. They had, first, the problem of getting the troops there, which took about all the motor transportation that they could rake up or scrape from anywhere. But having gotten the troops there in the position for jumping off, then they had to take essentially those same trucks for establishing their supply system.

The ammunition, for example, in that attack was based on the Port of Bone—which, as you know, was about sixty or seventy miles behind the front at the time they jumped off. That ammunition had to be brought from the port up to the rear of the lines where the troops with their own ammunition trucks could race back and get it. That ammunition supply wasn't established

From the Record

safely until the afternoon before the attack. At that time, the dumps where this ammunition was being piled were big enough so that the colonel in charge said he was sure he could meet any demand for ammunition.—*Lieut. Gen. Lesley J. McNair, Commanding General, U. S. Army Ground Forces, at a press conference.*

THE HOME FRONT

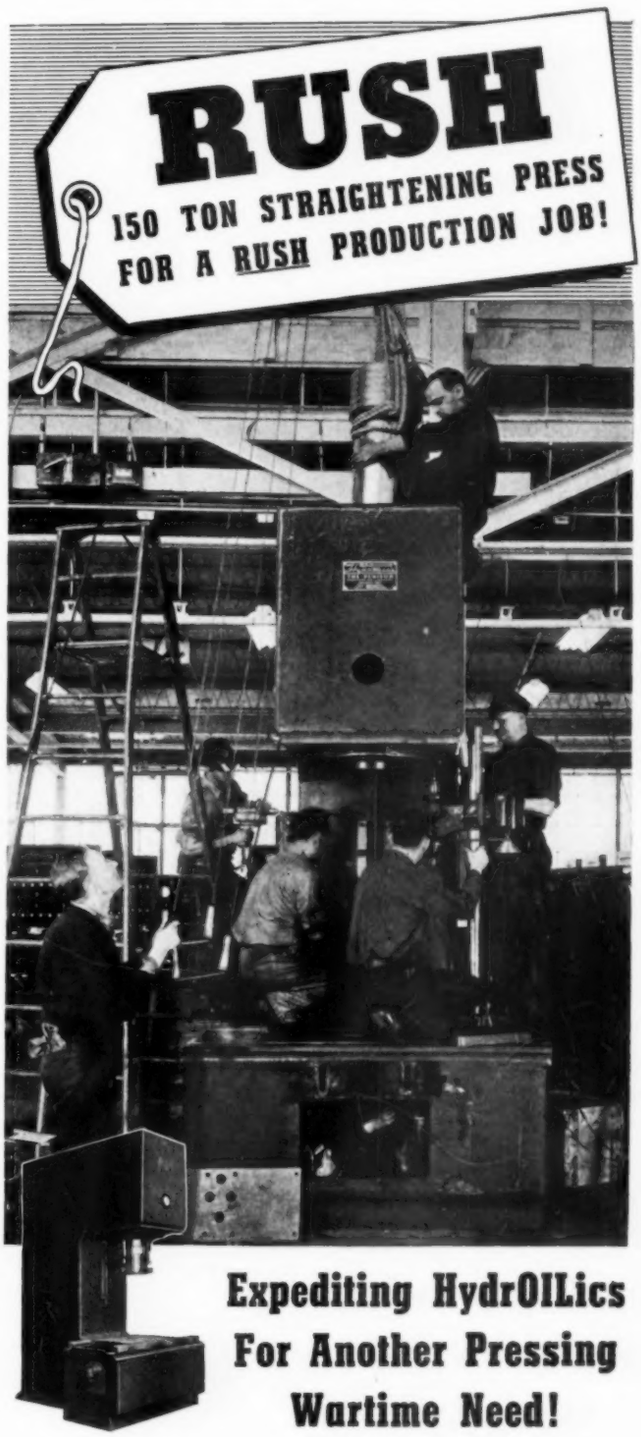
BY the time the emergency that resulted in the present World War was before our eyes—our closed eyes—our Regular Army had dwindled to a mere 12,000 officers and 170,000 enlisted men—a pathetic figure when one considers our strategic waterway across the Isthmus of Panama, our foreign possessions, and our responsible place in world affairs. We had not a single full-strength, fully equipped infantry division, not one. We had only four skeleton divisions—skeleton in strength and equipment—and five others on paper. And we had the record of having sunk unfinished modern battleships as the result of a disarmament-conference gesture.

A year ago I stood before an audience in Detroit and told them what our young men of the combat forces would have to face—hunger, thirst, cold, excessive heat, battle in deserts and in swamps, wounds, disease, and death. And I asked them if *they*, the civilians, could take it. I told them that what they could do for our troops that would have more meaning to those men on the battle fronts than any other thing was to make the soldiers proud of the people on the home front. That is all the man about to die ever asks of you—that he may be proud of you; that you conduct yourselves in dignity; that you save him from worry about you; that, like him, you despise cheapness, tawdriness, selfishness, meanness; that you do not whimper and complain; that you walk in the dignity of free men; that you, in your safety and your comfort, back him up.

Should I praise you for marvels of production? You could still do more—all of you know it—and yet not earn the stature of your fighting men who, when needs be, fight to the last round and the last man. Should I praise you for unity of effort? The Army expects that of every combat unit in the sight and sound of the fury of battle, when men's comrades fall bleeding beside them.

Should I praise you for nonpartisanship in all political matters? There are no Democrats and Republicans, New Dealers or Anti-New Dealers, blocs or pressure groups in Africa when your infantrymen and artillerymen stand to meet Rommel's tanks, in New Guinea when fever-ridden soldiers fight yard by yard through dismal swamps, in the air when tired and worn fliers are called out day after day to perform their daring missions.

Should I praise you for overcoming absenteeism in industry? What happens to the soldier who makes himself a voluntary absentee from the field of battle? And is the gold-brick welcomed by the men to whom he is not a comrade or is he ostracized? I do not wish to enter a one-sided controversy over absenteeism. It has many forms, and it is not exclusively confined to factories. When a farmer who *can* produce, even though it takes greater effort in 1943 than it did in 1942, fails to do so, isn't he an absentee? When a person of wealth fails to subscribe and pay up his fair share in the purchase of war bonds, isn't he an absentee? When a purchaser of bonds runs around the corner to the Post Office and stands in line to cash in his bonds, isn't he an absentee? When men and women capable of lending their time and efforts to war purposes do as little as they can as late as possible, aren't they absentees? When politicians make political capital of every little thing they can lay their hands on and magnify and make mountains out of molehills, aren't *they* absentees? I have a rather broad notion of absenteeism.—*Lieut. Gen. Ben Lear, formerly Commanding General, Second Army, in an address at Cincinnati, Ohio.*



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Preventive Maintenance

Part IV: The New Work Sheet Program

Col. T. L. Preble

THE year's headline story on preventive maintenance is heralded by Change 3 to Army Regulations 850-15, dated April 20, 1943. Among the forms now prescribed for motor-vehicle operation and maintenance use are three new PM work sheets and a new driver's trip ticket—designed to standardize and enforce official preventive-maintenance procedures. By making the use of these new forms *mandatory*, Change 3 accomplishes the standardization of preventive-maintenance procedures. This standardization will result in the fleet of military motor vehicles being maintained in first-class operating condition and will eliminate many needless vehicle failures, much unnecessary vehicle repair.

For the first echelon, a comprehensive preventive-maintenance reminder schedule is printed on the new driver's trip ticket and PM service record (W.D. Form No. 48, superseding W.D., Q.M.C. Form No. 237). This convenient check list covers the driver's daily and weekly preventive-maintenance duties—before and during operation, at halt and after operation—with provision for reporting deficiencies and corrective action taken. Form 48 is required on nontactical missions.

For the second echelon, all essential preventive-maintenance procedures are outlined in the new Preventive-Maintenance Service and Technical Inspection Work Sheets, of which there are three: (1) Work Sheet for Wheeled and Half-Track Vehicles—W.D., A.G.O. Form No. 461; (2) Work Sheet for Full-Track and Tanklike Wheeled Vehicles—W.D., A.G.O. Form No. 462; and (3) Work Sheet for Motorcycles—W.D., A.G.O. Form No. 463. For the third and fourth echelons, these work sheets provide a complete check list for "technical inspections"—superseding W.D., Q.M.C. Form No. 260.

The first work sheet, for wheeled and half-track vehicles, embodies a detailed check list for 1,000-mile and 6,000-mile maintenance. One hundred and forty-two different items are specified, grouped under such headings as road test; engine and accessories; chassis, body, and attachments; items special to half-tracks, amphibians, and trailers; tools and equipment. The second work sheet, for full-track and tanklike wheeled vehicles, itemizes the requirements for 50-hour and 100-hour maintenance. This list contains 139 different items, similarly broken down into road test, maintenance operation, auxiliary generator, items special to tanklike wheeled vehicles, armament, tools and equipment. The third form, a work sheet for motorcycles, specifies 86 different details to be checked during the 1,000-mile maintenance routine.

All three work sheets, together with the driver's trip ticket reminder list, are directly keyed to Technical Manual 9-2810, "Motor Vehicle Inspections and Preventive-Maintenance Servicing." While the check lists indicate the exact items to be inspected and serviced at certain intervals, TM 9-2810 provides detailed instructions on how to perform each individual task. For example, the wheeled and half-track work sheet, under "engine and accessories," simply specifies "cylinder head and gasket." TM 9-2810 explains the operation as follows: "Check for cracks or indications of oil, water, or compression leaks around studs, capscrews, and gasket . . . Tighten with torque-indicating wrench in the sequence and to the tension specified in the vehicle-maintenance manual." If, during the operation,

Colonel Preble is chief of the Preventive Maintenance Section of the Ordnance Department Tank-Automotive Center, Detroit, Mich.

further technical information is found to be required, each work sheet directs the mechanic to refer to the maintenance manual for the vehicle concerned.

In using any work sheet for 1,000-mile (or 50-hour) maintenance, the second-echelon mechanic fills in the full nomenclature of the vehicle, the registration number, mileage, date, and organization. He then goes straight through the pertinent check list—which covers the vehicle unit-by-unit in logical sequence—and follows the symbols indicating "inspect and correct," "clean," "tighten," "adjust," "special lubrication," and "serve." He marks down in each instance the result of his inspection or servicing, with symbols for "satisfactory," "adjustment required," "repair or replacement required," or "defect corrected." Ample space for additional "remarks" is also provided on the back of the sheet.

There, too, the driver and the mechanic sign their names on completion of the particular maintenance assignment. They enter the job-order number of any requests for higher-echelon repairs, the date the vehicle was forwarded for those repairs, and, later, the date of its return to the using organization.

The 1,000-mile work sheets, after execution, may be retained as a record until the next 6,000-mile inspection is made. The 6,000-mile work sheet and the technical-inspection work sheet may also be kept until the succeeding 6,000-mile check. Fifty-hour and one hundred-hour work sheets are handled in the same way. This filing procedure, however, is merely suggested. Work sheets may be destroyed, if desired, as soon as their job is done and the vehicle is clearly in first-rate condition.

That condition, for *every* military vehicle, is the goal of the whole preventive-maintenance program. It is now possible to forecast its attainment—as the PM work sheets, the new driver's trip ticket, and TM 9-2810 receive increasingly wide distribution throughout the Army. Proper use of these aids will have an important accelerating effect on mobility by reducing the need for higher-echelon repairs, easing the parts-supply problem, and increasing the interchangeability of automotive personnel. Since lack of preventive maintenance has been responsible for a large percentage of vehicle losses and time-costly repairs, actual operations on all fronts will be expedited by the measures which have now become law.

The development of those *standard* preventive-maintenance procedures required many months of thoroughgoing work by military and civilian specialists in automotive maintenance. Their conclusions, item by item, were tested against field realities before the PM work sheets assumed final form. The Army has now made the entire program official—a mandatory method for getting uniform results. Preventive maintenance has at last come of age.

Uniform preventive maintenance is now on paper. The job itself—and the kind of training required to do it properly—will be the urgent, ceaseless task of every officer and enlisted man assigned to motor maintenance. Quoting Change 3 to AR 850-15: "It is emphasized . . . that forms, records, and reports are merely aids. They are not a substitute for thorough practical work, physical check, and active supervision."

EDITOR'S NOTE.—Because of its timeliness, the present article on the work-sheet program has been substituted in the series of articles on preventive maintenance in place of the scheduled installment on the field supervision responsibilities of officers. The latter subject will be discussed in the September-October issue.

The series on preventive-maintenance began in the January-February 1943 issue of ARMY ORDNANCE (Vol. XXIV, No. 136, p. 110) with a discussion of its history and scope. Part II was published in the March-April issue (Vol. XXIV, No. 137, p. 322) and treated the driver's rôle in the field. "The Mechanic's Rôle in the Field," was the title of Part III which appeared in the May-June issue (Vol. XXIV, No. 138, p. 542). The series will be concluded with a discussion of the training program for officers, drivers, and mechanics.

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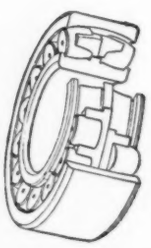

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Professional Digest

The Development of "Radar"

THE early development of Radar has been described in a joint statement by the War and Navy Departments. The term "Radar" is an abbreviation of "radio detecting and ranging." Radars, then, are devices which the allies use to detect the approach of enemy aircraft and ships and to determine the distance to the enemies' forces. Radar is used by static ground defenses to provide data for antiaircraft guns for use in smashing Axis planes through cloud cover, and by airplanes and warships.

It is one of the marvels made possible by the electron tube. Ultrahigh-frequency waves traveling with the speed of light can be focused to scan the air and sea. When they strike an enemy ship or airplane, they "bounce" back. Although radio waves travel at a speed of 186,000 miles a second, means have been developed for measuring the small space of time required for such signals to travel to a reflecting surface and return to a receiver, so that it is possible to determine the distance to a given target. Radars operate through fog, storms, and darkness, as well as through cloudless skies, and hence are superior to both telescopes and acoustic listening devices.

Radar is used for both defense and offense. In fact, the British, who call their similar apparatus the radio locator, say it was instrumental in saving England during the aërial *Blitz* of 1940 and 1941. At that time the locators spotted German raiders long before they reached a target area and thus gave the R.A.F. and ground defenses time for preparation. Since then, Radar has stood guard at many danger points along United Nations frontiers and at sea, warning of the coming of aërial and sea-borne enemy forces and contributing toward victory in combat. The new science has played a vital part in helping first to stem and them to turn the tide of Axis conquest.

It was first discovered in the United States in 1922, when scientists observed that reception from a radio station was interfered with by an object moving in the path of the signals. Accordingly, a radio receiver was set up on the banks of a river and the effects of signal reception caused by boats passing up and down the river were studied. The experiment of installing the receiver in a truck was also tried, and it was observed that similar disturbances were produced in the receiver when the truck moved past large buildings. Development work was immediately undertaken so that the new discovery might be used for detecting vessels passing between harbor entrances, or between ships at sea.

Thus far, it had been necessary to have the moving object pass *between* the radio transmitter and the receiver, which obviously limited the possible fields of application. In 1925, it was found that the surface of an object would act as a reflector of high-frequency radio waves. In other words, the radio signals sent out by a transmitter could be made to strike a target and then "bounce" back to a receiver. This made it possible to have both the transmitter and the receiver at the same location.

By 1930, research engineers were able to pick up reflected signals from planes passing overhead. By 1934, they had developed a satisfactory means of measuring the distance between the Radar transmitter and the target. Since then, other advances in the field have been made, some of which, after the war is over, will undoubtedly contribute to the security and comfort of a world at peace.

In order to prevent information which might facilitate development of Radar from reaching the enemy through publicity originating in the United States, it has been decided that no further items on the subject will be released until the Army

and Navy are convinced that the enemy already has the information from some other source.

NEW METHOD OF SHELL MANUFACTURE

CRITICAL material, time, and labor are saved by a new method, developed by a commercial company, of sizing the body of a 4.2 chemical mortar shell by hydraulic pressure instead of turning it on a lathe. The process, known as hydrosizing, is applicable to other types of artillery shells.

Sizing the inside of a shell to exact dimensions by the use of twelve lathes on tubular steel is slow, highly skilled work. In hydrosizing, the operation is performed by a machine using hydraulic pressure. This method saves 24 per cent in material or 205 tons of metal on each 100,000 shells and reduces time required from 6 minutes per shell by the old method to 30 seconds per shell.

THE NORDEN BOMBSIGHT

THE enemy undoubtedly has captured several of the famous Norden bombsights and for that reason the secrecy surrounding the intricate device has been relaxed somewhat, according to Col. John P. Kenny, commandant of the Air Forces Bombardier School at Midland, Tex. But he added that there was no cause for alarm because it would take Axis scientists two years or more to duplicate the bombsight.

The Norden sight has several thousand parts. Cadets learn enough about it to make superficial repairs, but bombsight men defy cadets or any one else to take one apart and put it together again without months of careful training. The sight, mounted directly behind a special piece of thick glass in the bombardier's compartment in the nose of the plane, has three ball-like elements, all encased in black metal. One element, containing the telescope and its adjusting machinery, is located to the bombardier's right; the second, containing the gyroscope, to his left on the same level; the third, directly under the gyroscope.

Before beginning the run on the target, the bombardier sets the sight for the chosen altitude and air speed, adjusts its gyroscope to spin with its axis perpendicular to the ground, lines up the sight with the plane's true direction, and prepares the bombs for dropping. When the run begins, the bombardier takes command of the ship.

During the next twenty-five seconds, the maximum time allowed in most combat runs, he becomes extremely busy. He must concentrate on his job even if antiaircraft shells are bursting on all sides. Success of the entire mission depends on how well he uses those twenty-five seconds.

Squinting through a telescope, which is part of the sight, his objective is to line two cross hairs inside the telescope so that they intersect across the target. Then he adjusts the sight so that even as the plane moves forward at three or four miles a minute the cross hairs automatically stay on the target. The sight does the rest. It has been synchronized to the chosen altitude and speed in such a manner that if the plane is put on the proper course, the cross hairs will follow the target.

In lining up the cross hairs, the bombardier uses four knobs which he manipulates with his right hand. Two of them bring the telescope to bear on the target; the other two adjust the ship's course to jibe with that bearing. The sight adjusts the course automatically for cross-wind drift.

The course is controlled either by a device attaching the sight to an automatic pilot, which guides the ship mechanically as the bombardier twists his knobs, or by a "pilot-directed indicator" which moves a needle in the cockpit as the knobs are turned, showing the pilot how to adjust the course.

After the bombardier has set the cross hairs at the point where they appear to be stationary on the target, he has done most of his job. When he shouts "Bombs away!" through the interphone, the pilot takes over the ship and heads for home.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

The Premise

AND THE PROMISE

Under the whip-lash of war necessity, and in the steady manufacture of special-purpose vehicles for our Army, Navy, Marine Corps, and Air Forces, Autocar product as well as Autocar Production has become more efficient. The premise of improvement for war leads logically to the promise of improved Autocar Trucks for peaceful purposes when all this nasty but necessary business is behind us. Better days will come and, with them, better Autocars.

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There is little difference in the operation when the sight is used to bomb a moving target, such as a ship or railroad train. The sight under such conditions automatically makes compensations for three motions—the plane's motion, the plane's drift sideways if there is a cross wind, and the target's motion. In the case of a zigzagging ship, however, the bombardier must guess which way it will be turning when the bombs arrive.

Picatinny Employees Suggest Improved Methods

A SAVING of 437,500 man-hours and $341,200 annually in the cost of operation at Picatinny Arsenal, N. J., has been effected by the Ordnance Department through adoption of 22 suggestions for improvement in work technique by civilian employees of the arsenal.

More than 600 such suggestions were submitted following a course in job-method instruction at the arsenal. Of these, 101 have been found practicable and are being put into use. The man-hours saved as well as the cash saving were estimated only on the first twenty-two in which results have so far been determined. Still larger savings are expected from the remainder now being put into effect. The job-method course is a part of the general training program given to supervising employees by the Army Service Forces. It is estimated that more than 75,000 civilian supervisors have been given the course.

Wooden Models Aid Tank Production

WOODEN tanks won't win the war, but they're doing a big job for victory by serving as models for new designs of the real steel battlewagons. Small, trusted crews of patternmakers, working in great secrecy at the Ordnance Department's Tank-Automotive Center and industrial facilities, constantly are building preliminary wooden models of weapons, vehicles, and components which are intended for future battles. Such models preceded many of the tanks and gun types at the front today. Some models now being built will be father to equipment which will see action on the battlefields of the future.

The principal function of the model shops is to transform ideas into reality—to give design engineers a clear view of how the ideas they have worked out on paper look and operate when actually made. Things that seem acceptable in theory often reveal shortcomings when put into practice. The model shops, in other words, save precious time and effort. Engineers, instead of waiting until a new-type vehicle or gun comes off the production line, have a model built on which they can check tolerances and clearances. If it is a full-scale vehicle model, personnel can climb into it, try the controls to see if they are placed and designed for greatest efficiency, and can make recommendations for improvement.

"Stowage" is made available at the model shops, so that it can be placed in vehicles to see that storage room is adequate. "Stowage" is a word used by the Army to designate all the technical, combat, maintenance, and personal equipment that must be "stowed" inside the vehicle when it goes into service. It includes items numbering in the hundreds, such as ammunition for vehicle guns and small arms, towropes, pickaxes, mattocks, spare parts, a spare gasoline can, fire extinguishers, first-aid kits, radio equipment, blanket rolls for the men, tools, and a long list of other items.

When assembled, the "stowage kits" occupy a large volume of space, making it necessary to design each vehicle so it will hold every item and still leave room for the men. Every inch of available space must be used to best advantage; there can be no waste. While it is possible to calculate this in advance to some degree, the most reliable test is actually to try to get the many items into the space provided. This can best be done on a full-size model. In that way the designers are assured before

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a new-type vehicle is built in final form that it will not be too small for the jobs it has to do. Wood is used for models for many reasons. It is cheaper, saves critical materials. It is fabricated with greater speed and without the need for special tooling. And wood lends itself more readily to modification. If too small, it can be built up with little trouble.

Ideas come to the model shops in the form of blueprints and drawings. The patternmakers use such woodworking equipment as lathes, band saws, circular saws, planers, facers, glue clamps, and miscellaneous hand tools. They build anything asked of them—a whole vehicle such as a tank or armored car, or some component such as a track, a wheel, transmission, or final drive. They build them full size or to scale as requested. The scale models are usually used when the principal purpose is to show

WOODEN MODEL OF THE M4 MEDIUM TANK

how the final product will appear. Models for preliminary tests of function are usually made full size.

The Tank-Automotive Center's model shop is under the jurisdiction of the Development Branch headed by Lieut. Col. Joseph M. Colby. It is supervised directly by Lieut. E. W. Tompsett, working under Capt. H. H. Brownson, chief of the Engineering Operations Section. Many models, of course, are built also by private industry. Regardless of where they are made, however, the fact remains that the woodworking shops and their skilled employees are accomplishing "tremendous trifles" on the home front which may become vital factors in tomorrow's triumphs.

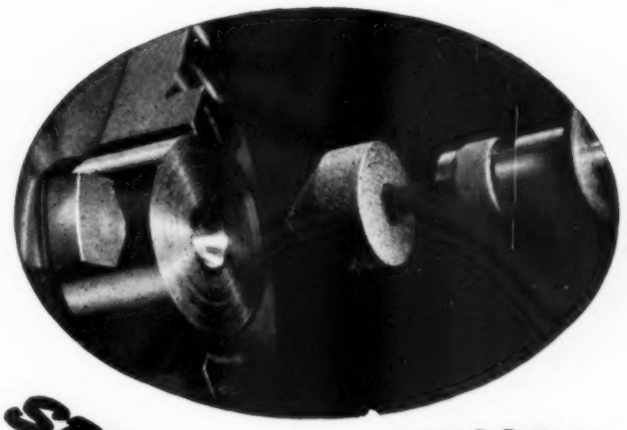
GAP-MILL PROCESS APPLIED TO GUN MANUFACTURE

FOR initiating and developing processes by which 15,000,000 pounds of steel and $7,500,000 in machine-hours can be saved in 1943, Col. G. A. Woody, head of the manufacturing department and second in command at Springfield Armory, has received the congratulations of Maj. Gen. Levin H. Campbell, Jr., Chief of Ordnance, and has had his achievement made the subject of a descriptive 8-page booklet in the series of Ordnance publications on "Tremendous Trifles."

General Campbell, in a letter of commendation, said: "I am delighted that your fine help in adapting the gap-mill process to machine-gun barrel production is being given this recognition. It is a fine tribute to you and to the Ordnance Department, to which both of us are so strongly attached."

Approximately thirty-three per cent per barrel in raw steel is saved as between the rolled forging and the gap-mill forging. Eight critical machine operations are eliminated, with a consequent saving of carboloy tools, grinding wheels, cutting tools, man-hours, power, shipping weight, and space.

The gap-mill process is one by which a bar of steel is stretched



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into proper proportions for machining into a gun barrel instead of being hammered out on a die as in a rolled forging. It involves a smaller bar of steel at the start and permits bringing the rough forging much nearer to the size of the finished barrel so that certain grinding and turning operations are eliminated when the steel goes on the machines. The gap-mill process for forgings is not new and has been used for years in the manufacture of high-grade automobile axles. But a year or so ago it occurred to Colonel Woody that it might be utilized for gun barrels.

In order that the new type of forgings could be machined at the armory, it was necessary to make a radical change in drilling technique. Colonel Woody and his Springfield Armory staff devised ways and means by which this could be done, and a complete change-over has been effected within the last year. The process was first applied to cal. .50 machine-gun barrels and is now being utilized for M1 (Garand) barrels.

Industrial Notes

A RUSH job in installing refrigerating equipment in Army vans for Medical Corps use in treating heat prostration during desert maneuvers was accomplished recently by the Gay Engineering Corporation of Los Angeles, a Carrier Corporation dealer. Equipment was installed to maintain a temperature within the vans of not in excess of 68 degrees and to provide a 150-gallon supply of water not in excess of 40-degrees. Cabinets, sinks, and tubs for complete immersion of patients were also provided.

A grinder-mounted wire brushing wheel, designed by the Osborn Manufacturing Company, Cleveland, to clean out the rubber that flows into the end holes of tank treads when the metal and rubber are vulcanized together, helped speed up tank production by performing the cleaning operation in a second or less—formerly a tedious hand operation.

The laboratories of the Hercules Powder Company have two of the world's fastest cameras which are used to photograph the detonation waves of explosions—and a "slow" explosion is one that lasts about one hundred millionths of a second. One, known as a rotating-drum camera, has been in use for some years, but a "rotating-mirror camera," ten times as fast, has recently been perfected.

A copy of Official Standard Specifications for Marking Shipments (No. 100-2D) can be obtained without charge upon request to the Marsh Stencil Machine Company, 20 Marsh Building, Belleville, Ill.

The first full-scale unit for making tapered nylon to replace Asiatic hog bristles in critically needed paint brushes started in April at a New Jersey plant of the plastics department of E. I. du Pont de Nemours & Company. The Government has preëmpted the unit's entire production for paint brushes required by the armed forces and war industries. A small semiworks, used in developing the synthetic bristle, has been producing tapered nylon in relatively limited quantities for the Government during the past few months.

Some months ago, the Morrison Engineering Company, Cleveland, developed a flame-type mouth and body annealing machine for 20-mm. steel cartridge cases. The efficient and speedy manufacture of 37-, 40-, 57-, 75-, 90-, 105-mm. and 3-inch steel cartridge cases created the need for a machine of the continuous type that would produce a uniform and satisfactory anneal before tapering and also a machine that would do the final mouth annealing.

In order to cover this range of sizes, three models of basically the same machine were designed (illustration on p. 141). The 3740 size will handle all 37-mm. and 40-mm. cases. The 5710 size will handle the 57-, the 75-, and the 105-mm. cases. Model 390 takes care of the 90-mm. and 3-inch antiaircraft cases. All models

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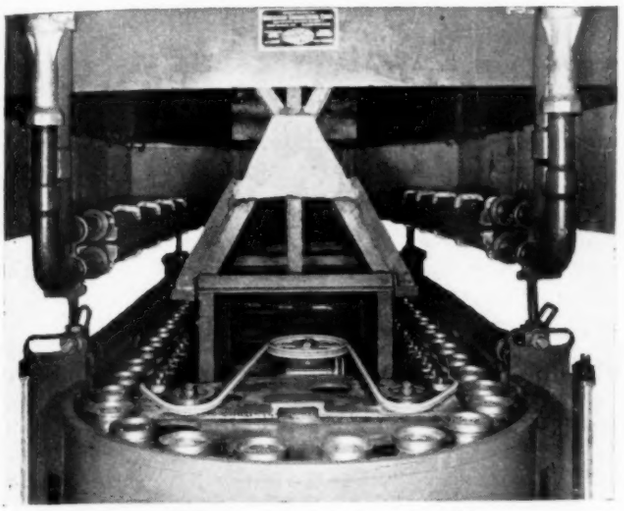
are basically of the same design—the difference being in the size of the machine to handle the various diameters and lengths of the cartridge cases.

A new asphalt-treated fiber protector for packing-list envelopes, recently developed by the Dennison Manufacturing Company, Framingham, Mass., to be used in place of critical metal protectors, has been approved by the Office of the Chief of Ordnance. The new protector is embossed to fit over bulky packing lists or instruction booklets, and prevents tearing and ripping due to rough handling and damage from adverse weather conditions.

An instructive film on the maintenance of air brakes and air



MORRISON CONTINUOUS ANNEALING MACHINE

control devices has been released nationally to distributors and is being augmented by showings arranged by the field-service staff of Bendix-Westinghouse Company. Arrangements for securing the film can be made with the company at Elyria, Ohio. There is no charge for the film.

Labor-management officials of the Marmon-Herrington Company, Indianapolis, Ind., recently inaugurated a new military ritual at the company's plant. A large sign placed over the main employees' entrance reads: "Through These Gates March the Soldiers of Production." Thoroughfares in the plant have been given such names as "MacArthur Drive," "Casablanca Plaza," and "Wainwright Street." Employee-buglers sound such calls as assembly, mess call, and recall during the day. The program aims to remind each worker of his essential part in the war effort.

DEVELOPMENTS IN RIVETING

RADIO frequency energy now is used to detonate explosive rivets and speed production of aircraft. The radio unit assures instant control of temperature in the firing tip, eliminating time consumed in heating an electric iron to operating degrees and in frequent changes from one tip temperature to another. This method is adaptable only to large-scale production. The electric riveting iron, now used widely, is still preferred for many types of work.

Explosive rivets were introduced two years ago, breaking a bad bottleneck in fastening airplane sections where riveters could work from only one side. They are installed at a rate of fifteen to twenty a minute, as contrasted with two to four a minute for most "blind" fasteners. The rivet has a high explosive secreted in a cavity at the end of the shank. Heat applied to the

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rivet head detonates the charge. The explosion expands the charged end of the shank, forming a "blind" head and setting the rivet.

Engineers of Radio Corporation of America and of the Du Pont Company developed the radio unit, which consists of an oscillator together with a specially prepared applicator to concentrate current directly into the rivet head. As current is induced in the head, the heat it creates fires the charge. Radio energy not only gives instant temperature control but prolongs indefinitely the life of the firing tip. The tip is always cool, an important safety factor. The same tip can be used for any kind of rivet head.

Another development is an automatic rivet injector designed to obviate lost motion and the loss of rivets resulting from conventional riveting practice in the aircraft industry, recently announced by the manufacturing research department of Vultee Aircraft, Inc. Seen as an aid to speeding up production, the device is a portable riveting tool with an automatic injector which inserts the rivet in the hole and performs the riveting operation without the necessity of removing the tool from the work.

In addition to speeding up work, the new tool is said to eliminate the loss of large quantities of rivets and the necessity for expensive sorting machines, the gathering of fallen rivets from floors, and the loss of time required for sorting. Another advantage of the unit is that it leaves the operator's hands free to perform the riveting operation.

By combining the unit with another device developed by the Vultee Field Division, known as the "riveting yoke," complete riveting operations can be carried on by one person. This combination also makes it possible to provide a hopper-type feed containing large quantities of rivets. The automatic rivet injector is designed to fit any standard riveting gun. The unit is compact and adds very little weight to the gun.

Small-Arms Ammunition

Ammunition of the calibers used in rifles and machine guns is required in astronomical quantities in this global war. Millions of rounds of small-arms ammunition are fired daily in desert and steppe combat and by our infantrymen in South Sea jungles. It has been estimated that 50 fighting planes alone can use up 300,000 rounds of small-arms ammunition in one minute. One whole division of 10,000 men in Napoleon's army would not have used that much ammunition in a day's battle. According to the President, we produced 10,250,000,000 rounds of small-arms ammunition in 1942.

That our facilities for producing small-arms ammunition are considerably more than adequate to meet the huge demand should be a source of great pride to all Americans. This is due to the farsightedness of the Ordnance Department, which, in conjunction with old-line ammunition companies, laid extensive plans for expanding the manufacture of war materials years before our entry into the war. As pointed out in the April issue of *Machinery*, Frankford Arsenal assumed a leading rôle in this work through the perfection of a model factory for turning out small-arms ammunition by the latest developments in mass-production methods.

Model factories for the production of caliber .30 and .50 cartridges were set up and in actual operation before the end of 1939. The methods here developed were adopted by both the British and Canadian Governments as standard in the procurement of equipment for small-arms ammunition factories. It was largely on the basis of the Frankford Arsenal methods that old-line ammunition companies and other industrial concerns which had had no previous experience in the production of small-arms ammunition were able to undertake the building and operation of new ammunition plants for the Government.

Book Reviews

LEE'S LIEUTENANTS—A STUDY IN COMMAND (Vol. II: CEDAR MOUNTAIN TO CHANCELLORSVILLE). By Douglas Southall Freeman. New York: Charles Scribner's Sons. $5.

WITH the appearance of the second volume of Dr. Freeman's superb study of the subordinate generals of the Army of Northern Virginia there once more arises the question of its relative worth to the reader and to the military student of today. As individuals we are busied as never before, and as Americans we are torn with anxiety for our nation's part in the world-wide conflict. It may seem to many but natural to confine their heavier reading to the struggle of all free men against the vast forces of barbarism. Yet reflection tells us the wisdom of turning to our past history in order to gain a clearer understanding of the present. This truth is more evident in the field of military history than in any other for "the more it changes, the more it is the same."

Though the present volume carries on the author's story without break or gap of any kind, there is in this second volume a real though subtle difference. Much of this is due to the developments of the war: The troops and their officers alike are rapidly becoming veterans; faulty staff work is far less noticeable; and the generals who have proved not quite up to the acid test of battle have been transferred or quietly shelved. A fair share, however, of the changing tempo of this second volume seems to be due to the growing finesse with which Dr. Freeman handles the manifold difficulties of writing what may well be termed "multiple biography." General Lee fades gently into the background of the conflict as his lieutenants emerge in ever stronger outline. Yet there always remains to him the critical and heartbreaking task of filling the ever-recurring gaps in the ranks of his brigade, division, and corps commanders because of the toll continuously and pitilessly exacted in battle by death or by crippling wounds.

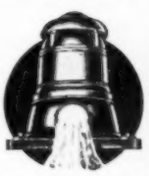
At the very outset it is necessary for the reader to understand that this is not primarily a study of tactic and strategy, of battle and campaign; it is rather the mental and moral development of the individual field officer which holds the forefront throughout the book. And it is in this field that Dr. Freeman is at his best; for to the tremendous fund of knowledge of the American Civil War which is his he adds a deep and personal friendship for the officers of Lee's army. It is manifest in all his books, yet here more than ever before, and it makes a living, breathing thing of this latest work. To this reviewer, it is this sense of personal friendship with these splendid soldiers that constitutes the real reward for the student of Dr. Freeman's books. Jackson, Stuart, Hood, Early, Hill, and their comrades turn these pages into a personal joy as well as a storehouse of history. F. W. F. G.

GUN CARE AND REPAIR. By Charles Edward Chapel. New York: Coward-McCann, Inc. 454 pp. $3.75.

OF THAT mighty company of devotees of the rifle, pistol, and shotgun which fortunately constitutes a considerable percentage of America's manhood, not a few have always possessed more than superficial interest in the weapons they wield. They like to take them apart and see "what makes the wheels go 'round." They like to embellish them with fancy stocks, ornate engraving, superaccurate sights, and what not. One thing leads to another, and many a man who, when he acquired his first firearm, scarcely knew how to load and unload it, ends his days as an expert, if nonprofessional, gunsmith.

These mechanically minded fellows learn much by trial and error. But they soon come to realize that time and effort can

When Hell Broke Loose In Tunis



Layne Wells and Pumps were in the thick of things when hell broke loose to crush the Axis troops in Tunis. Only the military authorities could tell of how they came through, but if they were not destroyed by the enemy—or our own terrific fire power, those sturdily built, tough and long lasting Wells and Pumps are still in there pitching—producing millions of gallons of water daily.

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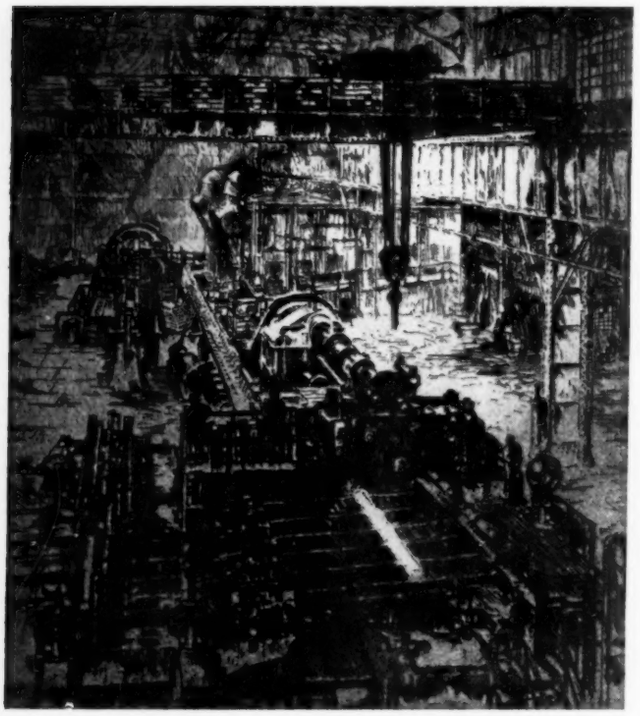

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Book Reviews

be saved by consulting existing works on the gunsmith's art. The demand for such publications has apparently always existed, and the response has been reasonably generous. The first really comprehensive gunsmith's manual produced in this country seems to have been that by Stelle and Harrison which appeared in 1883. Then followed several decades during which no really important contribution to this specialized field came forth. During the past twenty-five years, however, gun lovers have been blessed by works from the hands of Clyde Baker, Ed Crossman, Perry D. Frazer, Jim Howe, Alvin Linden, W. F. Vickery, Colonel Whelen, and others. Now appears upon the scene the volume which is the subject of this review.

Charles Chapel appears to have attempted to cover, sometimes briefly, sometimes extensively, most of the branches of gunsmithing as today practiced. His work is divided into forty chapters which deal with such divers subjects as "General Tools and Equipment" (Chapter 3), "Inletting the Action and Bedding the Barrel" (Chapter 11), "Etching and Engraving" (Chapter 12), "Welding" (Chapter 18), "Rifling" (Chapter 23), "The Garand Rifle" (Chapter 31), "Pistol and Revolver Problems" (Chapter 35), "Shotgun Problems" (Chapter 36), "Restoring Antique Firearms" (Chapter 38), and "How To Get a Gunsmithing Job" (Chapter 40). Scattered through the book are forty-five plates in the form of drawings, most of which are fairly well executed but some of which appear to have been prepared rather to increase the number of illustrations than to convey particularly helpful information.

The general impression gained by the reviewer as a result of a cursory study of this volume is that the author has probably attempted to kill too many birds with one stone by the inclusion of much material which will rarely be of use to the average reader. This, however, is no new fault and is less to be deprecated than would be the production of a volume of equal size devoted to but one or two aspects of the gunsmith's problems. Without doubt, there is much useful matter between the covers of this publication, the appearance of which at the present time is distinctly opportune in view of the increased interest in small arms of all types now manifest. C. G.

GERMANY'S MASTER PLAN. By Joseph Borkin and Charles A. Welsh. New York: Duell, Sloan & Pearce, Inc. 339 pp. $2.75.

THIS is a book which should be in the possession of every one interested in world economics. The authors picture how Germany influenced our unpreparedness through her international cartel system—a system which built up Germany's industries to the detriment of our own and that of other countries. Our production of electrical equipment, drugs, and chemicals, as well as aluminum and magnesium, was hindered to a greater extent than we cared to acknowledge.

World conquest was Germany's principal motive in every economic move she made during the past twenty years, a master plan such as the world had never seen. She made herself practically self-sufficient in war materials, except possibly gasoline and oils. The foundation for this self-sufficiency plan was based on legions of patents filed in foreign countries, including, of course, the United States—against which one of her principal efforts was aimed—but our statesmen did not appear to see the possible effect this plan would have on the prime industries of this country.

The German industrialists, aided by some of the aristocracy, were the engineers and bankers of this master plan; they were responsible for the induction of Hitler into German politics and his rapid rise to power. The question is asked as to whether Hitler was permitted to deliver his blow too soon. The authors feel that such was the case and that this was a fatal mistake. Let us hope so. F. H. W.

Book Reviews

STRATEGY OF THE WAR IN ASIA. By Lawrence K. Rosinger. Washington: Foreign Policy Association. 36 pp. $0.25.

THIS study analyzes the situation in the Pacific after Pearl Harbor. The United Nations decided upon the conduct of the war without emotion and on the basis of political and military necessity. Germany comes first as an antagonist, because of Nazi military superiority over Japan, and represents about eighty per cent of the German-Japanese coalition.

The strategy is to do the maximum possible against Japan while placing the major emphasis on Germany. Japan has a labor shortage, and her machine tools, shipping, and productive capacity are not available or located where effective use can be made of the new resources obtained by conquest in Asia. Naval supremacy will contribute to final defeat, but is not the entire story. Naval and air supremacy must always be employed with ground troops for whom the former prepare the way.

Japanese strategy is probably not to wait until Germany is defeated and the full force of the allies is turned against her. She probably hopes for a negotiated peace, which is also the expected German strategy. The book recommends solidification of the existing unity of the United Nations through new military actions and closer political understanding. T. K. V.

WE THOUGHT WE HEARD THE ANGELS SING. By Lieut. James C. Whittaker. New York: E. P. Dutton & Company. 139 pp. $1.50.

THE title is somewhat misleading to the average book buyer and might have been made more impressive by substitution of "The Will To Live," or, as was otherwise suggested, "We Dared To Live." The book tells the harrowing experience of Capt. Eddie Rickenbacker and his crew of brave men. Many civilians today grouch about food rationing, yet this band of eight men lived for days on food and drinking water scarcely sufficient to keep a child alive. Thirsty and hungry for three weeks, surrounded by sharks, and with the shadow of death hovering over them, they appealed to God for rescue; their appeal was answered, and all but one were saved. This is an epic which should be read by every one interested in the story of the suffering and rescue of this band of brave, God-fearing men. F. H. W.

CRYPTOGRAPHY. By Lawrence Dwight Smith. New York: W. W. Norton & Company. 164 pp. $2.50.

THE book opens with a very complete and interesting story of the evolution of secret writing. It passes quickly to transposition ciphers, substitution ciphers, and thence to cryptanalysis. The methods by which ciphers are broken down and the reasons for the insecurity of all types of secret writing are explained or hinted at. Numerous problems are given, with solutions in the back of the book. For the amateur cryptanalyst it is a fine elementary textbook, and for the advanced student it is refreshing reading. It is well indexed and clearly and simply written. T. K. V.

THE FIRST CENTURY OF FLIGHT IN AMERICA. By Jeremiah Milbank, Jr. Princeton: Princeton University Press. 240 pp. $2.75.

AN authoritative 100-year account of aëronautical history in America dating back to 1783 when Prof. J. A. C. Charles made his first venture into the air with his hydrogen balloon. The period covered starts at the date given above and ends when aviation supplanted aërostation. Accounts are given of the experiences of inventors and aëronauts, many of whom were showmen but nevertheless brave ones, since they cheerfully accepted risk of life and limb in the name of progress. A very worthwhile book not only for those interested in aëronautical history but also for the reader who can appreciate progress. F. H. W.

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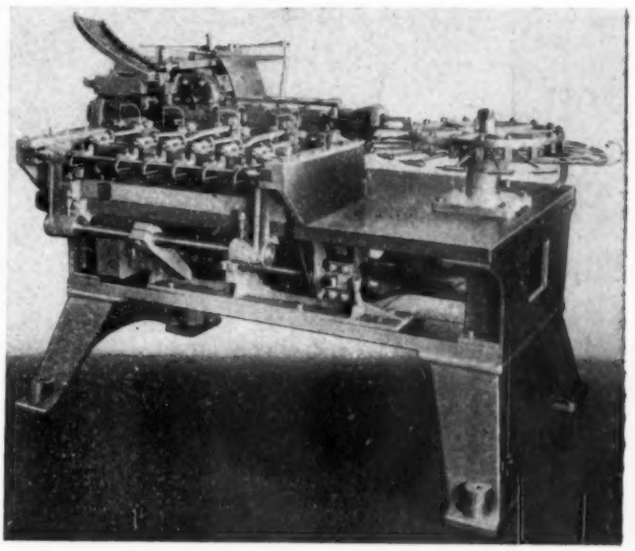

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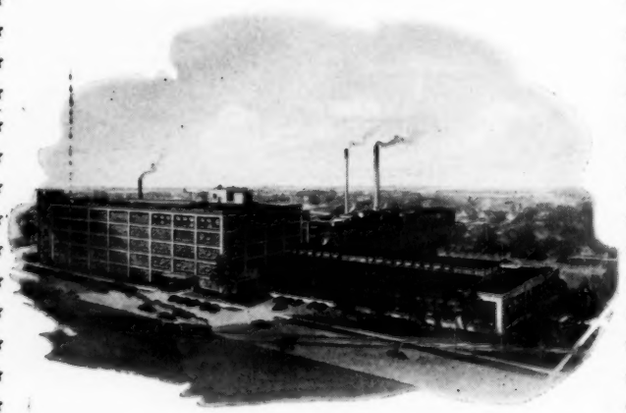

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Book Reviews

How To Prepare for Military Fitness. By Lieut. Col. François D'Eliscu. New York: W. W. Norton & Company. 216 pp. $1.96.

THE author is probably the best man in the world by training and ability to write this book. He has trained Olympic swimming teams, has been a national vice-president of the A.A.U., and has taught and coached athletics for over twenty years.

The book covers in great detail the elements of physical testing, calisthenics, conditioning, wartime swimming, American Judo, disarming, and all other matters connected with personal combat. It is clearly written with a profusion of illustrations showing graphically and in great detail the technique of the subject described.

It is recommended to all physical instructors and to the individual officer and man in the service who wishes to improve his fitness and to make himself master of his adversary in hand-to-hand combat. It would well behoove the civilian also to take a very personal interest in his physical condition since victory on the home front, as well as in the field, is to the strong of body and keen of mind. T. K. V.

Masters of Mobile Warfare. By Elbridge Colby. Princeton: Princeton University Press. 152 pp. $2.

THIS is a highly fascinating account by an experienced military author who describes the practice of the art of mobility in warfare. He selected three of the most outstanding exponents of this art to illustrate his subject: the Duke of Marlborough, Frederick the Great, and Napoleon. Mobility in present-day armies exceeds that of the armies commanded by these brilliant leaders, but the rules of the game remain the same. The lessons portrayed by the author are highly significant, even though our present armies command weapons which were not dreamed of in the past. This book is recommended to Army officers as well as to civilians who have an interest in world happenings; any time employed in studying its pages will be well spent. F. H. W.

Through Hell to Dunkerque. By the Marquis de la Falaise. Harrisburg: The Military Service Publishing Company. 166 pp. $2.50.

THIS is a factual account by an eyewitness attached to the Twelfth Royal Lancers, a British mechanized cavalry regiment. It is probably the only worth-while story so far published covering the engagements leading to and through the epic embarkation at Dunkerque. Space here does not permit entering deeper into the account presented, but its reading will hold the attention of any one interested in following the Lancers and their companions through their Flanders adventure. It is highly recommended for reading when the day's work is done. F. H. W.

Technical Manuals, Handbooks, Etc.

Micromeritics. By J. M. Dallavalle. New York: Pitman Publishing Corporation.

In this book the author introduces a new word, "micromeritics,"—the science of small particles. He attempts to coordinate the present known facts regarding small particles and to present them in a form which will be of use to the engineer or research worker interested in such particles, including powders, dust, smoke, suspensions, soil, etc. This has been done in an admirable manner.

The major part of the book is concerned with the technology of small particles including methods of determining size and size distribution, the theory of sieving and grinding, precipitation of dust, flow of water through soils, and other industrially important subjects. Each of these topics is discussed thoroughly, with ample reference to the literature (over 700 references are given). C. Z.

Book Reviews

What You Should Know about the Signal Corps. By Harry M. Davis and F. G. Fassett, Jr. New York: W. W. Norton & Company. 214 pp. $2.50.

The first of a series that will be awaited and read by the uninformed who want an easy description of the separate branches of the Army. Very instructive and in language which can be easily understood by the average reader. T. K. V.

Ski Track on the Battlefield. By V. A. Firsoff and M. A. Barnes. New York: A. S. Barnes & Company. 158 pp. $2.

While not a military manual, this book has the professional touch that makes it of interest to the military reader. It is a fascinating war book, outlining the early history of skiing, equipment, and maneuvers. It covers the campaigns of ski troops in Finland, Russia, Norway, the Alps and the Balkans, and recent activities in the Finnish-Russian War. The United States and Canada are briefly discussed in general terms. The book is profusely illustrated and well written. It is felt that this is a valuable contribution to military literature covering a new auxiliary arm. T. K. V.

Blitz French. By Georges Nicot. Harrisburg: Military Service Publishing Company. 136 pp. $0.75.

A pocket book, limp back, with English-French words and phrases divided into natural sections according to classification. Phonetic spelling is added as an aid to self-pronunciation. More comprehensive than most books of this kind. T. K. V.

Manual of Explosives, Military Pyrotechnics, and Chemical Warfare Agents. By Jules Bebie. New York: The Macmillan Company. $2.50.

A helpful compilation of data, largely from Colver's "High Explosives" and Faber's "Military Pyrotechnics." Compounds are listed alphabetically—usually under chemical names, trade names, symbols, and abbreviations. Complete chemical structural formulae are shown clearly and are quite helpful to the amateur. A list of "permissible explosives" is given. Descriptive matter is clear and concise, though there are a few factual errors. Two serious omissions from the list of pyrotechnic agents are sodium oxalate and gilsonite. Curiously enough, a dissertation on the two spellings "fuse" and "fuze" is found under the heading "Black Powder." Included are a good bibliography and a list of the more important modern patents. B. E. A.

Books Received

WHAT YOU SHOULD KNOW ABOUT SPIES AND SABOTEURS. By Will Irwin and T. M. Johnson. New York: W. W. Norton & Company. 219 pp. $2.50.

BASIC PHYSICS FOR PILOTS AND FLIGHT CREWS. By E. J. Knapp. New York: Prentice-Hall, Inc. 112 pp. $1.65.

EZRA AND ME. By Harry Persons Taber. New York: Coward-McCann, Inc. 180 pp. $2.

NATIONAL EMERGENCY STEELS. Cleveland: The American Society for Metals. 72 pp. $0.50.

THE NEW PROFESSION. By Averell Broughton. New York: E. P. Dutton and Company. 243 pp. $2.

AMERICA'S FIGHTING PLANES IN ACTION. By Reed Kinert. New York: The Macmillan Company. 143 pp. $2.50.

AMATEURS AT WAR. Edited by Ben Ames Williams. Boston: Houghton-Mifflin Company. 494 pp. $3.

JEEPS AND JESTS. By Bruce Bairnsfather. New York: G. P. Putnam's Sons. $2.

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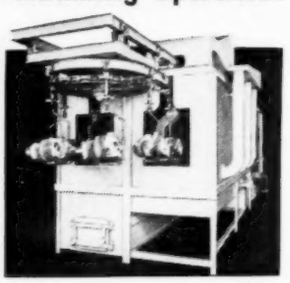

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